



# NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

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## MBA PROFESSIONAL REPORT

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### The Use of System Dynamics Analysis and Modeling Techniques to Explore Policy Levers in the Fight Against Middle Eastern Terrorist Groups

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By:           **Benigno R. Alcantara Gil,  
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**June 2005**

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**REPORT DOCUMENTATION PAGE**

Form Approved OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.

|  |   |  |   |
|--|---|--|---|
| <b>1. AGENCY USE ONLY (Leave blank)</b>  | <b>2. REPORT DATE</b><br>June 2005                              | <b>3. REPORT TYPE AND DATES COVERED</b><br>MBA Professional Report |   |
| <b>4. TITLE AND SUBTITLE:</b><br>The Use of System Dynamics Analysis and Modeling Techniques to Explore Policy Levers in the Fight Against Middle Eastern Terrorism.   |   | <b>5. FUNDING NUMBERS</b><br>N/A                                   |   |
| <b>6. BENIGNO R. ALCANTARA GIL, MASAHIRO MATSUURA, CARLOS MOLINA MONZON &amp; IOANNIS SAMOTHRAKIS</b>  |   |  |   |
| <b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b><br>Naval Postgraduate School<br>Monterey, CA 93943-5000  |   | <b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>                    |   |
| <b>9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b><br>N/A   |   | <b>10. SPONSORING/MONITORING AGENCY REPORT NUMBER</b>              |   |
| <b>11. SUPPLEMENTARY NOTES</b><br>The views expressed in this thesis are those of the authors and do not reflect the official policy or position of the Department of Defense or the U.S. Government.  |   |  |   |
| <b>12a. DISTRIBUTION / AVAILABILITY STATEMENT</b><br>Approved for public release; distribution is unlimited  |   | <b>12b. DISTRIBUTION CODE</b>                                      |   |
| <b>13. ABSTRACT (maximum 200 words)</b><br>The objective of this project is to use analysis and modeling techniques of Systems Dynamics to capture the causal relationships of Middle Eastern groups' terrorist activities against the U.S. based on their ideological drivers, as well as the effect of U.S. policies that create dynamics and affect performance and outcomes. The main focus of this analysis is the terrorist groups' human resources. The hypothesis is that Middle Eastern terrorism against the U.S. is affected by the U.S. level of military presence and/or investment in the Middle Eastern nations. A considerable and lasting reduction in fatalities originated by Middle Eastern groups' terrorist attacks against the U.S. can be achieved through a policy that reduces both the human resources available to terrorist groups and their attack capability (level of sophistication). The study covers the implications of this resource reduction policy, which may include incremental military investment, defection motivators, anti-terrorism and the use of counter-terrorism operations. These operations will reduce the sophistication as well as the recruitment rate to levels where cells' functionality will be impaired, and thus unable to carry high lethality attacks. |   |  |   |
| <b>14. SUBJECT TERMS</b><br>TERRORISM AIMED AT THE UNITED STATES, TERRORISM DYNAMICS, DYNAMIC MODELING OF TERRORISM, TERRORISM DYNAMIC BEHAVIOR  |   |  | <b>15. NUMBER OF PAGES</b><br>97        |
| <b>16. PRICE CODE</b>  |   |  |   |
| <b>17. SECURITY CLASSIFICATION OF REPORT</b><br>Unclassified   | <b>18. SECURITY CLASSIFICATION OF THIS PAGE</b><br>Unclassified | <b>19. SECURITY CLASSIFICATION OF ABSTRACT</b><br>Unclassified     | <b>20. LIMITATION OF ABSTRACT</b><br>UL |

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**THE USE OF SYSTEM DYNAMICS ANALYSIS AND MODELING  
TECHNIQUES TO EXPLORE POLICY LEVERS IN THE  
FIGHT AGAINST MIDDLE EASTERN TERRORIST GROUPS**

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Submitted in partial fulfillment of the requirements for the degree of

**MASTER OF BUSINESS ADMINISTRATION**

from the

**NAVAL POSTGRADUATE SCHOOL**

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# **THE USE OF SYSTEM DYNAMICS ANALYSIS AND MODELING TECHNIQUES TO EXPLORE POLICY LEVERS IN THE FIGHT AGAINST MIDDLE EASTERN TERRORIST GROUPS**

## **ABSTRACT**

The objective of this project is to use analysis and modeling techniques of Systems Dynamics to capture the causal relationships of Middle Eastern groups' terrorist activities against the U.S. based on their ideological drivers, as well as the effect of U.S. policies that create dynamics and affect performance and outcomes. The main focus of this analysis is the terrorist groups' human resources. The hypothesis is that Middle Eastern terrorism against the U.S. is affected by the U.S. level of military presence and/or investment in the Middle Eastern nations. A considerable and lasting reduction in fatalities originated by Middle Eastern groups' terrorist attacks against the U.S. can be achieved through a policy that reduces both the human resources available to terrorist groups and their attack capability (level of sophistication). The study covers the implications of this resource reduction policy, which may include incremental military investment, defection motivators, anti-terrorism and the use of counter-terrorism operations. These operations will reduce the sophistication as well as the recruitment rate to levels where the functionality of terrorist cells will be impaired, and thus unable to carry high lethality attacks.

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## **ACKNOWLEDGMENTS**

First, we must thank our countries and our military services for sending us here to the Naval Postgraduate School. Their faith in our abilities has enabled us to continue our education, enhance our careers, and experience the best another culture has to offer.

Also, and most specifically to our studies, we extend our sincerest thanks and appreciation to our dedicated advisors, Professor Tarek Abdel-Hamid and Professor John Mutty. It is only through your guidance and dedication that we have come so far along this grueling thesis path.

Above all, we wish to recognize the immeasurable contributions of our beloved wives: Erika Vizcaino Payero, Mikie Matsuura, Ana Gloria Molina and Maria Nikolaou. Without you, we are ships without courses, and only with you have we been able to steer through these challenging waters. We could not have done this were it not for your support, your comfort, and above all your patience. Thank you for making this journey with us.

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## I. INTRODUCTION

### A. BACKGROUND AND RELEVANT EVENTS

Boosted by the tragic events of September 11, 2001, Middle Eastern terrorist organizations have moved to the forefront of threats to U.S. national security. Most of these organizations were founded in the decades of the 1970s and 1980s, but since the 1990s they have significantly underlined their presence through the increase in lethality of their missions.

It is quite telling that five of the seven sponsor states<sup>1</sup> that are included in an official U.S. government terrorist list<sup>2</sup> are located in the Middle East<sup>3</sup>. On the other hand, it is worth noting that, during 2003, fewer attacks were carried out against the U.S. in the Middle East than in either Latin America or Europe. There is no doubt that the September 11<sup>th</sup> attacks have forcibly challenged the belief of many Americans that they live under an invulnerable U.S. umbrella, and have also revived memories linked to the Pearl Harbor attack in the Second World War.

Before September 11<sup>th</sup>, terrorism was characterized by the U.S. administration as one problem among many other big issues of U.S. security. After the attacks, terrorism came to occupy the dominant position among the affairs typically addressed in all U.S. security policy discussions<sup>4</sup>.

---

<sup>1</sup> The Middle East sponsor states are: Syria, Iran, Iraq, Libya and Sudan. The other two are: Cuba and North Korea.

<sup>2</sup> Patterns of Global Terrorism, Released by the Office of the Coordinator for Counterterrorism, April 29, 2004, available on the Internet: <http://www.state.gov/s/ct/rls/pgtrpt/2003/31751.htm> [last accessed June 01, 2005].

<sup>3</sup> In Figures 1, 2 and 3 brief descriptions of terrorism through statistics that are based on regional factors, source: From DOD (Office of the Coordinator for Counterterrorism), Patterns of Global Terrorism 2003 April 29, 2004 Appendix G, available on the Internet: <http://www.state.gov/s/ct/rls/pgtrpt/2003/31751.htm> [last accessed June 01, 2005].

<sup>4</sup> Raphael Perl, Issue Brief for Congress, *Terrorism, the Future, and U.S. Foreign Policy* (The Library of Congress, April 11, 2003), p. CRS 2-3.

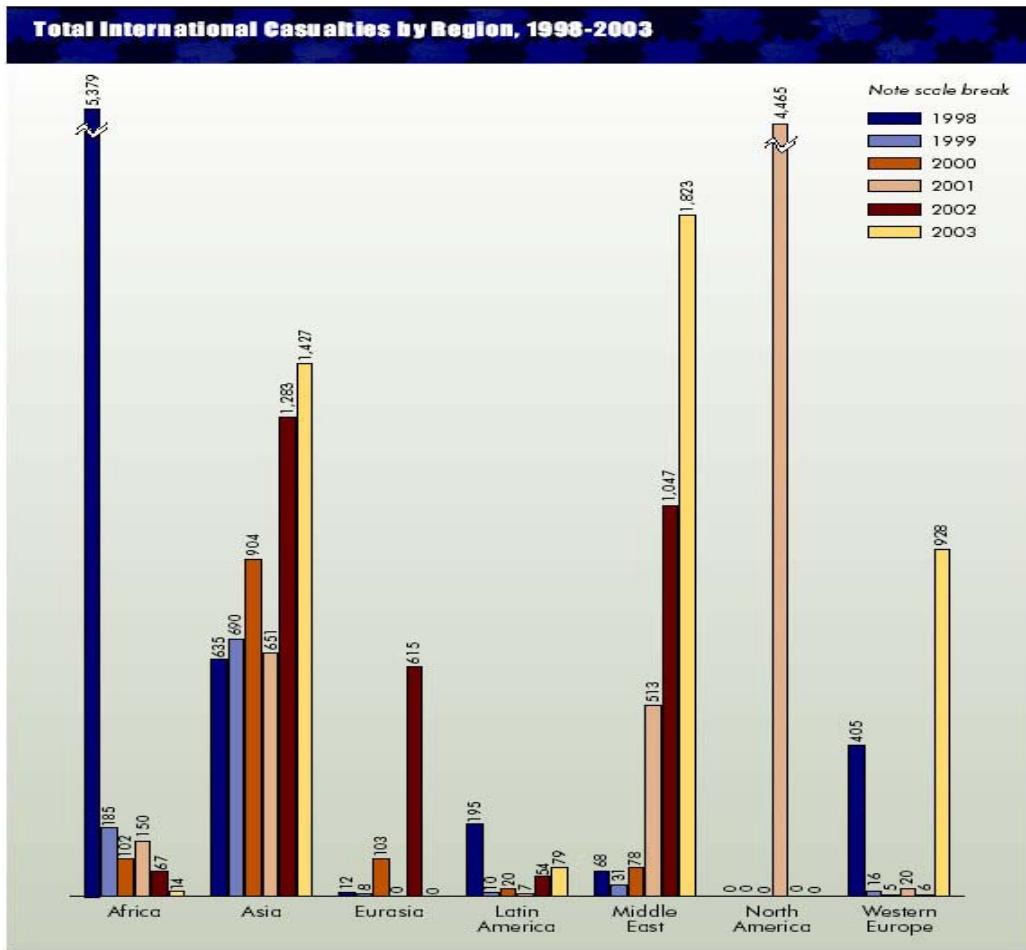


Figure 1. Total International Casualties from Terrorist Acts by Region in the Last Six Years, (Source: from DOD (Office of the Coordinator for Counterterrorism), Patterns of Global Terrorism 2003 April 29, 2004 Appendix G)

Figure 1 supports the previous discussion of America becoming more concerned with terrorism after September 11, 2001. The graph illustrates that, for a period of six years (1998-2003) and with the exception of 9/11, there were no casualties from major terrorist acts in North America; it also shows that approximately 4,465 fatalities resulted from the traumatic events of 9/11. Although speculative and thus highly debatable, it could also be inferred that the U.S. became a target of major terrorist acts after its incursions in the Middle East in the 70s and 80s (closer interactions or hostilities with Libya, Iraq, Israel, and Palestine).

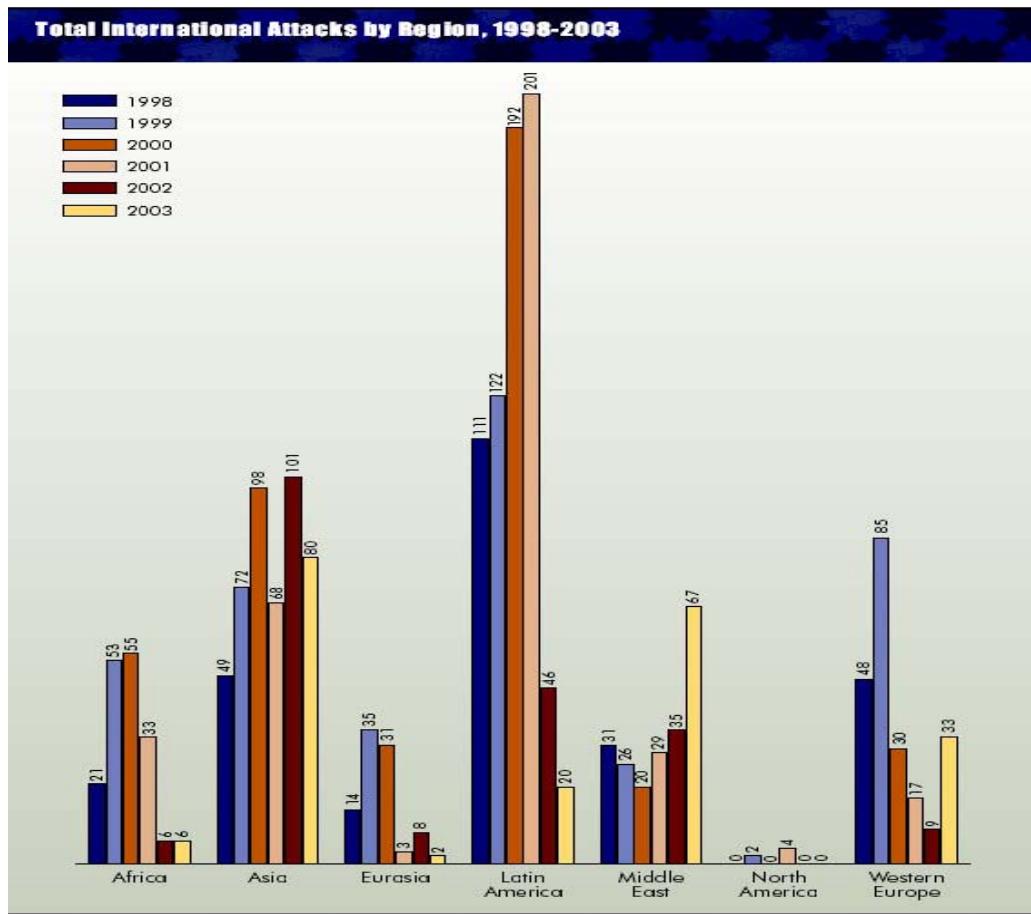


Figure 2. Total International Terrorist Attacks by Region in the Last Six Years,  
 (Source: from DOD (Office of the Coordinator for Counterterrorism), Patterns of  
 Global Terrorism 2003 April 29, 2004 Appendix G)

Figure 2 depicts the number of terrorist attacks per region in the last six years. Surprisingly, the Middle East is not the most dangerous place, with regard to terrorism, as it is perceived to be by many. Latin America, Asia and Western Europe all have greater incidences of terrorist attacks.

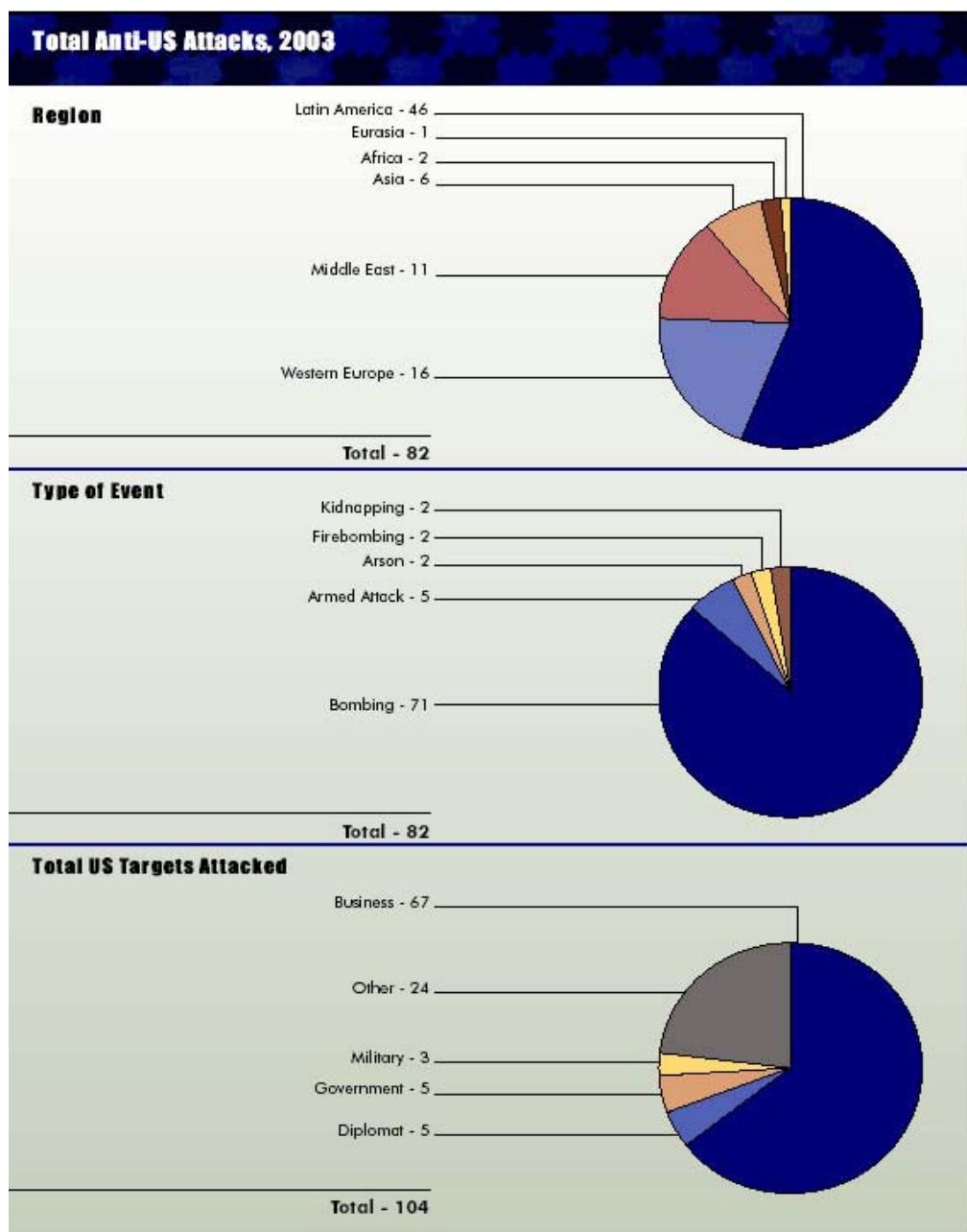


Figure 3. Total Anti-US Attacks, 2003, (Source: from DOD (Office of the Coordinator for Counterterrorism), Patterns of Global Terrorism 2003 April 29, 2004 Appendix G)

Figure 3 provides a more specific depiction of anti-U.S. attacks by region, type of event and type of target. The information was based on data for the year 2003. Only 13% of all anti-American attacks occurred in the Middle East region; the majority of attacks took place in Latin America. However, the degree of lethality of the Latin American

attacks was relatively low compared to those in the Middle East (Figure 1). It must also be noted that 88% of the attacks were bombing attacks and that 64% were against businesses. Only 12% of the attacks were against military, governmental, or diplomatic targets. This is an important detail that strongly relates to the actual definition of “Terrorism”. There are many different definitions of terrorism that have been adopted by official members of the international community. The academic consensus of the United Nations defines<sup>5</sup> terrorism as follows:

Terrorism is an anxiety-inspiring method of repeated violent action, employed by (semi-) clandestine individual, group or state actors, for idiosyncratic, criminal or political reasons, whereby - in contrast to assassination - the direct targets of violence are not the main targets. The immediate human victims of violence are generally chosen randomly (targets of opportunity) or selectively (representative or symbolic targets) from a target population, and serve as message generators. Threat- and violence-based communication processes between terrorist (organization), (imperiled) victims, and main targets are used to manipulate the main target (audience(s)), turning it into a target of terror, a target of demands, or a target of attention, depending on whether intimidation, coercion, or propaganda is primarily sought.

When compared side by side, the definitions of terrorism vary depending on the source. As an illustration, an analysis performed by Alex P. Schmid<sup>6</sup> on the use of definitional elements of terrorism compares the widely accepted characteristics of terrorism and assigns a weight to each one in terms of their frequency of use in official forums. In Table 1, twenty-one characteristics have been gathered according to the frequency of their appearance in the existing definitions. The most popular characteristic is violence/force (83.5%), followed by politics.

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<sup>5</sup> This definition is available on the Internet: [http://www.unodc.org/unodc/terrorism\\_definitions.html](http://www.unodc.org/unodc/terrorism_definitions.html) [last accessed June 01, 2005].

<sup>6</sup> Alex P. Schmid et al, *Political Terrorism: A New Guide to Actors, Authors, Concepts, Data Bases, Theories and Literature* (New Brunswick, Transaction Books, 1988), pp. 5-6.

| Element  | Frequency (%) |
|--|---------------|
| Violence, force  | 83.5          |
| Political  | 65            |
| Fear, terror emphasized  | 51            |
| Threat   | 47            |
| (Psychological) effects and (anticipated) reactions                            | 41.5          |
| Victim-target differentiation  | 37.5          |
| Purposive, planned, systematic, organized action                               | 32            |
| Method of combat, strategy, tactic   | 30.5          |
| Extra-normality, in breach of accepted rules, without humanitarian constraints | 30            |
| Coercion, extortion, induction of compliance                                   | 28            |
| Publicity aspect   | 21.5          |
| Arbitrariness; impersonal, random character, indiscrimination                  | 21            |
| Civilians, noncombatants, neutrals, outsiders as victims                       | 17.5          |
| Intimidation   | 17            |
| Innocence of victims emphasized  | 15.5          |
| Group, movement, organization or perpetrator                                   | 14            |
| Symbolic aspect, demonstration to others                                       | 13.5          |
| Incalculability, unpredictability, unexpectedness of occurrence of violence    | 9             |
| Clandestine, covert nature   | 9             |
| Repetitiveness; serial or campaign character of violence                       | 7             |

Table 1. Frequencies of definitional elements in 109 definitions of terrorism  
 (Source: from Alex P. Schmid, Political Terrorism: A New Guide to Actors, Authors, Concepts, Data Bases, Theories and Literature (New Brunswick, Transaction Books, 1988)

In order to analyze a specific terrorist group, specialists have chosen to use different techniques, some of them based on motivation and ideology, and others on objectives and levels of activity. Generally, the ones with the most significant levels of activity are the Latin American Groups, but in the area of lethality and popularity the scepter is kept by Islamic Groups<sup>7</sup>.

An official document containing a list of identified terrorist organizations has been prepared by the US Department of State<sup>8</sup>; it is shown in Table 2. The fact that 48% of the groups who are on that list originate in the Middle East region is evidence enough to explain the significant and highly stressed presence of Middle Eastern terrorist organization<sup>9</sup> matters in today's U.S. political and foreign policy arenas. According to Kenneth Katzman, the popularity of these groups, as well as their economic strength, is the result of the displeasure in the Islamic World at the "unjust" treatment of Arabs in the Israeli-Arab peace process by the U.S. (double standard policy), or the "illegal"<sup>10</sup> invasion and occupation of Muslim lands<sup>11</sup> (Operation Desert Storm against Iraq).

It is broadly accepted that it is very difficult to find a solution, a remedy or cure against terrorism. Unfortunately, terrorism has existed for a long time and it is likely that it will continue to exist in the future. Perhaps the phrase: "Once a terrorist, always a terrorist," reflects clearly not only the complications but also the difficulties experienced by governments in their efforts against terrorism.

---

<sup>7</sup> Kenneth Katzman, CRS Report for Congress, *Terrorism: Near Eastern Groups and State Sponsors, 2002* (The Library of Congress, February 13, 2002), p. CRS-2.

<sup>8</sup> US Department of State Report *Patterns of Global Terrorism* (Office of Counterterrorism, Washington DC, April 29, 2004). The Middle Eastern Terrorist groups are in bold.

<sup>9</sup> In Tables 3, 4, 5, and 6, it is intended to give a brief description of each one of these groups.

<sup>10</sup> There is no U.N. resolution to legalize the second Persian Gulf War.

<sup>11</sup> Kenneth Katzman, p. CRS-2.

- 1. Abu Nidal Organization (ANO)**
2. Abu Sayyaf Group (ASG)
- 3. Al-Aqsa Martyrs Brigade**
- 4. Ansar al-Islam**
- 5. Armed Islamic Group (GIA)**
6. Aum Shinrikyo
7. Basque Fatherland and Liberty (ETA)
8. Communist Party of the Philippines/New People's Army (CPP/NPA)
9. Continuity Irish Republican Army (CIRA)
10. Gamaa al-Islamiyya (Islamic Group)
- 11. HAMAS (Islamic Resistance Movement)**
12. Harakat ul-Mujahidin (HUM)
13. Islamic Movement of Uzbekistan (IMU)
14. Jaish-e-Mohammed (JeM) (Army of Mohammed)
15. Jama'at al-Tawhid wa'al-Jihad
16. Jemaah Islamiya (JI)
- 17. Kahane Chai (Kach)**
- 18. Kongra-Gel/ PKK (KGK, formerly Kurdistan Workers' Party, KADEK)**
19. Lashkar-e Tayyiba (LeT)
20. Lashkar i Jhangvi
21. Liberation Tigers of Tamil Eelam (LTTE)
- 22. Mujahedin-e Khalq Organization (MEK)**
23. National Liberation Army (ELN)
- 24. Palestinian Islamic Jihad (PIJ)**
- 25. Palestine Liberation Front (PLF)**
- 26. Popular Front for the Liberation of Palestine (PFLP)**

**27. PFLP-General Command (PFLP-GC)**

**28. al-Qa'ida**

29. Real IRA

30. Revolutionary Armed Forces of Colombia (FARC)

31. Revolutionary Nuclei (formerly ELA)

32. Revolutionary Organization 17 November (R17N)

**33. Revolutionary People's Liberation Army/Front (DHKP/C)**

**34. Salafist Group for Call and Combat (GSPC)**

35. Shining Path (Sendero Luminoso, SL)

36. United Self-Defense Forces of Colombia (AUC)

Table 2. U.S. Department of State Designated Foreign Terrorist Organizations List  
(Source: from U.S. Department of State, Patterns of Global Terrorism  
(Washington DC, April 29, 2004). The Middle East Terrorist groups have bold  
indication.

Table 2 provides the list of known terrorist organizations as recognized by the U.S. Department of State. Since this study will focus on the Middle Eastern groups (in bold font in Table 2), and to provide the reader with a general profile, Tables 3-6 present a concise description of the most relevant Middle Eastern groups. The source of this illustrative table is the reputable National Memorial Institute for the Prevention of Terrorism database, available at their website: <http://www.tkb.org>

| Abu Nidal Organization (ANO)  |            |            | al-Aqsa Martyrs Brigades   |            |            | al-Qa'ida   |            |            | Ansar al-Islam   |            |            |
|---|------------|------------|--|------------|------------|---|------------|------------|--|------------|------------|
| Incidents   | Casualties | Fatalities | Incidents  | Casualties | Fatalities | Incidents   | Casualties | Fatalities | Incidents  | Casualties | Fatalities |
| 77  | 565        | 188        | 0  | 0          | 0          | 24  | 6,401      | 3,578      | 3  | 20         | 17         |
| 0 Domestic Incidents  |            |            | 0 Domestic Incidents   |            |            | 4 Domestic Incidents  |            |            | 2 Domestic Incidents   |            |            |
| 77 International Incidents  |            |            | 0 International Incidents  |            |            | 20 International Incidents  |            |            | 1 International Incidents  |            |            |
| <b>Date Formed:</b><br>11/22/1974<br><b>Strength:</b><br>Group is inactive<br><b>Classification:</b><br>Nationalist/Separatist, Communist/Socialist<br><b>Last Attack:</b><br>1994-01-29<br><b>Financial Sources:</b><br>Government sponsorship from Syria, Libya, and Iraq |            |            | <b>Date Formed:</b><br>2000<br><b>Strength:</b><br>Unknown number of members<br><b>Classification:</b><br>Nationalist/Separatist<br><b>Last Attack:</b><br>2004-06-20<br><b>Financial Sources:</b><br>Reports have linked al-Fatah and Yasir Arafat to financial payments to the group |            |            | <b>Date Formed:</b><br>Late 1980s<br><b>Strength:</b><br>Approximately 50,000 members<br><b>Classification:</b><br>Religious<br><b>Last Attack:</b><br>2004-06-20<br><b>Financial Sources:</b><br>Bin Laden's personal fortune and a variety of his investments and business partnerships throughout the years have contributed to the pool of Al-Qaeda funds. Additionally, Al-Qaeda receives funding from charities all over the world. |            |            | <b>Date Formed:</b><br>Formed Dec. 2001<br><b>Strength:</b><br>Less than 500 members<br><b>Classification:</b><br>Religious<br><b>Last Attack:</b><br>2005-01-12<br><b>Financial Sources:</b><br>Al Qaeda seed money Local sources |            |            |

Table 3. A Brief Description of Some Fundamental Characteristics of Abu Nidal Organization (ANO), Al-Aqsa Martyrs Brigade, al-Qa'ida, Ansar al-Islam (Source: from National Memorial Institute for the Prevention of Terrorism database), available on the Internet: <http://www.tkb.org>

| Armed Islamic Group   |            |            | Hamas  |            |            | Kurdistan Workers' Party  |            |            | Mujahedin-e-Khalq (MeK)   |            |            |
|---|------------|------------|--|------------|------------|---|------------|------------|---|------------|------------|
| Incidents   | Casualties | Fatalities | Incidents  | Casualties | Fatalities | Incidents   | Casualties | Fatalities | Incidents   | Casualties | Fatalities |
| 61  | 259        | 107        | 411  | 2,768      | 559        | 84  | 214        | 38         | 16  | 80         | 34         |
| 4 Domestic Incidents  |            |            | 329 Domestic Incidents   |            |            | 19 Domestic Incidents   |            |            | 1 Domestic Incidents  |            |            |
| 57 International Incidents  |            |            | 82 International Incidents   |            |            | 65 International Incidents  |            |            | 15 International Incidents  |            |            |
| <b>Date Formed:</b><br>1992<br><b>Strength:</b><br>Less than 100 members<br><b>Classification:</b><br>Religious<br><b>Last Attack:</b><br>2001-08-31<br><b>Financial Sources:</b><br>GIA funds itself by robbing banks, raiding villages, and "taxing" the inhabitants of areas under their control. They use guns stolen from police posts and the bodies of dead soldiers |            |            | <b>Date Formed:</b><br>1987<br><b>Strength:</b><br>Greater than 1,000 members<br><b>Classification:</b><br>Religious,<br>Nationalist/Separatist<br><b>Last Attack:</b><br>2005-01-18<br><b>Financial Sources:</b><br>Iran (state-sponsored);<br>Donations (especially through Islamic charities);<br>Remittances from Arab expatriates; Commercial enterprises (sewing and weaving centers and cattle farms) |            |            | <b>Date Formed:</b><br>1974<br><b>Strength:</b><br>Greater than 1,000 members<br><b>Classification:</b><br>Nationalist/Separatist,<br>Communist/Socialist<br><b>Last Attack:</b><br>2004-05-23<br><b>Financial Sources:</b><br>The PKK's largest funding sources are drug smuggling and extortion. The group also receives funding through charities, commercial establishments, and remittances from Europe. Syria, Iran, and Iraq have provided some aid to the PKK |            |            | <b>Date Formed:</b><br>Formed in 1963; began armed operations in 1971<br><b>Strength:</b><br>Greater than 500 members<br><b>Classification:</b><br>Leftist<br><b>Last Attack:</b><br>2001-01-21<br><b>Financial Sources:</b><br>For years the group received all of its military assistance, and most of its financial support, from the Iraqi regime. In addition, the MEK uses front organizations to solicit contributions from expatriate Iranian communities, as well as a number of charities which operate as human rights organizations monitoring the Iranian government, or which claim to provide relief for Iranian refugees, are in fact collecting funds for the MEK. |            |            |

Table 4. A Brief Description of Some Fundamental Characteristics of Armed Islamic Group, Hamas, Kurdistan Workers' Party, Mujahedin-e Khalq Organization (MEK) (Source: from National Memorial Institute for the Prevention of Terrorism database), available on the Internet: <http://www.tkb.org>

| Palestine Liberation Front  |            |            | Palestinian Islamic Jihad (PIJ)   |            |            | Palestinian Revolution Forces General Command   |            |            | Popular Front for the Liberation of Palestine (PFLP)   |            |            |
|---|------------|------------|---|------------|------------|---|------------|------------|--|------------|------------|
| Incidents   | Casualties | Fatalities | Incidents   | Casualties | Fatalities | Incidents   | Casualties | Fatalities | Incidents  | Casualties | Fatalities |
| 7   | 1          | 1          | 44  | 618        | 122        | 13  | 23         | 19         | 98   | 631        | 155        |
| 0 Domestic Incidents  |            |            | 13 Domestic Incidents   |            |            | 0 Domestic Incidents  |            |            | 19 Domestic Incidents  |            |            |
| 7 International Incidents   |            |            | 31 International Incidents  |            |            | 13 International Incidents  |            |            | 79 International Incidents   |            |            |
| <b>Date Formed:</b><br>1959<br><b>Strength:</b><br>Unknown number of members<br><b>Classification:</b><br>Other, Leftist<br><b>Last Attack:</b><br>1990-05-30<br><b>Financial Sources:</b><br>Libya & Iraq (formerly) |            |            | <b>Date Formed:</b><br>Late 1970s<br><b>Strength:</b><br>Less than 1,000 members<br><b>Classification:</b><br>Religious,<br>Nationalist/Separatist<br><b>Last Attack:</b><br>2003-06-19<br><b>Financial Sources:</b><br>Iran provides an estimated \$2 million of state-sponsored funding to PIJ annually |            |            | <b>First Mentioned:</b><br>April 22, 1985<br><b>Strength:</b><br>Unknown number of members<br><b>Classification:</b><br>Other<br><b>Last Attack:</b><br>1987-12-14<br><b>Financial Sources:</b> |            |            | <b>Date Formed:</b><br>December 1967<br><b>Strength:</b><br>Approximately 800 members<br><b>Classification:</b><br>Nationalist/Separatist,<br>Communist/Socialist<br><b>Last Attack:</b><br>2005-01-15<br><b>Financial Sources:</b><br>Syria provides financial support and safehaven to the PFLP. Libya has also provided financial support. Up until the 1980s, the Soviet Union and China were the PFLP's main supporters due to their ideological similarities |            |            |

Table 5. A Brief Description of Some Fundamental Characteristics of Palestinian Islamic Jihad (PIJ), Palestine Liberation Front (PLF), Popular Front for the Liberation of Palestine (PFLP), PFLP-General Command (PFLP-GC), (Source: from National Memorial Institute for the Prevention of Terrorism database), available on the Internet: <http://www.tkb.org>

| DHKP-C  |  |            | Salafist Group for Preaching and Combat (GSPC) |            |            |  |  |  |
|---|--|------------|--|------------|------------|--|--|--|
| Incidents   | Casualties   | Fatalities | Incidents                                      | Casualties | Fatalities |  |  |  |
| <a href="#">72</a>  | 90   | 20         | <a href="#">6</a>                              | 12         | 3          |  |  |  |
| 16 Domestic Incidents   |  |            | 5 Domestic Incidents                           |            |            |  |  |  |
| 56 International Incidents  |  |            | 1 International Incidents                      |            |            |  |  |  |
| <b>Date Formed:</b><br>1978   | <b>Date Formed:</b><br>1996  |            |  |            |            |  |  |  |
| <b>Strength:</b><br>Less than 1,000 members   | <b>Strength:</b><br>Approximately 300 members  |            |  |            |            |  |  |  |
| <b>Classification:</b><br>Leftist   | <b>Classification:</b><br>Religious  |            |  |            |            |  |  |  |
| <b>Last Attack:</b><br>2004-06-24   | <b>Last Attack:</b><br>2004-12-13  |            |  |            |            |  |  |  |
| <b>Financial Sources:</b><br>While the group's activities are focused in Turkey, their funding comes from Western Europe, where much of the leadership is currently located. The group reportedly finances most of its operations through armed robberies and extortion | <b>Financial Sources:</b><br>Algerian expatriates and GSPC members abroad, especially in Western Europe; In addition, Algeria has accused Iran and Sudan of providing support to Algerian extremists |            |  |            |            |  |  |  |

Table 6. A Brief Description of Some Fundamental Characteristics of Revolutionary People's Liberation Army/Front (DHKP/C), Salafist Group for Call and Combat (GSPC) (Source: from National Memorial Institute for the Prevention of Terrorism database), available on the Internet: <http://www.tkb.org>

## B. RESPONSES TO TERRORISM

The war against terrorism includes two types of actions: antiterrorism (defensive measures) and counterterrorism (offensive measures). Antiterrorism involves "defensive measures used to reduce the vulnerability of individuals and property to terrorist acts, to include limited response and containment by local military forces<sup>12</sup>." Counterterrorism is defined as "offensive measures taken to prevent, deter, and respond to terrorism<sup>13</sup>." Moreover, the goal for antiterrorism could be described as follows: "to prevent attacks as well as to minimize the effects if one should occur<sup>14</sup>", while aiming to eliminate the terrorist organization and its political power. Conversely, counterterrorism includes

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<sup>12</sup> Kirkhope, The Basics: Combating Terrorism, (Terrorism Research Center, Jan 03, 2005), p. 1, available on the Internet:  
<http://www.terrorism.com/modules.php?op=modload&name=News&file=article&sid=5671&mode=thread> [last accessed June 01, 2005].

<sup>13</sup> Ibid., p. 5.

“spoiling action, deterrence, and response and follows a terrorist event<sup>15</sup>”. In the combat against terrorism, unity of efforts, legitimacy, patience, perseverance, and restraint are required.

Based on their desire to defeat terrorism, nations often face a disharmony between goals and courses of action<sup>16</sup>. Raphael Perl argues that: “The efforts to combat terrorism are complicated by a global trend towards deregulation, open borders, and expanded commerce<sup>17</sup>. Another unpleasant situation that can take place is the reduction of personal freedom or, even more onerously, the adoption of a myopic view on several fundamental human rights. Such unpleasant situations are usually characterized as “collateral losses”.

Unfortunately, the structures that terrorist organizations use are totally different from those that the U.S. and its international partnerships, such as NATO, are used to dealing with. For instance, the NATO structure was not prepared to respond to suicide attacks against civilians inside cities. The September 11<sup>th</sup> incidents revealed that the U.S. had little recent practical experience in dealing with terrorist organizations.

Analysts, in their endeavor to understand the function of a terrorist group, have come to the conclusion that there are three trends<sup>18</sup> which best represent terrorist organizations. The first one is structural: the groups are loosely organized and self-financed. The second is motivational: religiously or ideologically motivated organizations are predominant in the field of terrorism. The last trend is the creation and development of international links among terrorist organizations, which permit the exchange of technological information, political advice, and training.

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<sup>14</sup> Ibid., p. 5.

<sup>15</sup> Kirkhope, p. 5.

<sup>16</sup> Raphael Perl, p. CRS-5. In consolidation democracies such as the United States, the constitutional limits within which a policy must operate are often seen by some to conflict directly with a desire to secure the lives of citizens against terrorist activity more effectively.

<sup>17</sup> Ibid.

<sup>18</sup> Ibid., p. CRS-8.

Besides these trends, it has to be mentioned that in the war against terrorism, the media remains as the most powerful force in confrontations between terrorists and governments<sup>19</sup>. Perl states: “Influencing public opinion may impact not only the actions of governments but also those of groups engaged in terrorist acts. From the terrorist perspective, media coverage is an important measure of the success of a terrorist act or campaign. Conversely, governments can also use the media in their efforts to arouse world opinion against a state sponsor of terrorism or groups using terrorist tactics<sup>20</sup>.”

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<sup>19</sup> In Table 7 are described some potential uses of Mass Media. Source: from Alex P. Schmid and Janny de Graaf, *Violence as Communication* (London, Sage, 1982), pp. 53-54.

<sup>20</sup> Raphael Perl, p. CRS-8.

1. Instill fear in a mass audience
2. Polarize public opinion
3. Gain publicity by agreeing to clandestine interviews
4. Demand publication of a manifesto
5. Provoke government overreaction
6. Spread false and misleading information
7. Bring about the release of prisoners
8. Attract converts and support to a cause
9. Coerce the media by assaulting journalists
10. Profit from “free advertising”
11. Discredit public officials while being held hostage
12. Divert public attention by bombing their way onto front page
13. Use the media to send messages to comrades to another country
14. Excite public against the legitimate government
15. Bolster the terrorist group’s morale
16. Gain the Robin Hood image by fighting “injustice”
17. Obtain information on counterterrorist strategies
18. Identify future victims
19. Acquire information about popular support for the terrorist group
20. Exploit the exaggerated media image of a powerful, omnipotent group

Table 7.     Uses of Mass Media by Modern Terrorist (Source: from Alex P. Schmid and Janny de Graaf, Violence as Communication (London, Sage, 1982), pp. 53-54)

Governments and international coalitions can use some “instruments” to combat international terrorism, such as:

### **1.     Economic Sanctions**

Sanctions against regimes can be either unilateral or multilateral. Sanctions can be used against nations that have been characterized as sponsors or supporters of terrorist groups. Moreover, such actions can be targeted at capturing the assets of individual

terrorist organizations. Examples of blocked assets of Middle East Terrorism List States are described in Table 8.

| <b>Country</b>   | <b>Assets in U.S.</b>   |
|--|---|
| IRAN<br>(added to terrorism list<br>January 19, 1984)  | \$23.2 million, consisting of blocked diplomatic property and related accounts. (A reported additional \$400 million in assets remain in a Defense Dept. account pending resolution of U.S.-Iran military sales cases <sup>21</sup> ) |
| IRAQ<br>(on list at inception, December 29, 1979.<br>Removed March 1982, restored to list<br>September 13, 1990) | \$2.356 billion, primarily blocked bank deposits. Includes \$596 million blocked in U.S. banks' foreign branches, and \$173 million in Iraqi assets loaned to a U.N. escrow account.  |
| SYRIA<br>(on list since inception).  | No blocked assets.  |
| SUDAN<br>(added August 12, 1993)   | \$33.3 million in blocked bank deposits.  |
| LIBYA<br>(on list since inception)   | \$1.073 billion, primarily blocked bank deposits.   |

Table 8. Blocked Assets of Middle East Terrorism List States (As of End 2000),  
(Source: from 2000 Annual Report to Congress. January 2001)

## 2. Economic Inducements

These inducements might include efforts to affect economic and social conditions to eliminate breeding grounds for terrorists. It has been indicated that "most terrorists worldwide are unemployed or underemployed, with virtually nonexistent prospects for economic advancement."<sup>22</sup> Some experts believe that the fight against poverty may constitute the main pillar in the battle against terrorism. Moreover, education could be the second pillar. With economic wealth and education, it should be possible to reduce

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<sup>21</sup> Pincus, Walter. Bill Would Use Frozen Assets to Compensate Terrorism Victims. Washington Post, July 30, 2000.

<sup>22</sup> Raphael Perl, pp. CRS-9, 10.

terrorism through a change of lifestyle and culture in general. On the other hand, some others argue<sup>23</sup> that these factors can only insignificantly influence terrorism because they occupy the lowest position in the list of terrorism motivators.

### **3. Covert Actions by the U.S.**

Covert action is defined by U.S. law as activity meant “to influence political, economic, or military conditions abroad, where it is intended that the role of the United States Government will not be apparent or acknowledged publicly<sup>24</sup>.” Such actions are comprised mainly of passive monitoring in order to clarify the capabilities and the targets of the terrorist groups. Most of the time, covert actions have to deal with: the publicity of false information, promotion of divisions between the political and military branches of organizations, and conflicts between organizations. The most dangerous part of these actions appears when agents operate covertly in foreign countries. In the event that such operations are revealed, it is quite possible to create a significant diplomatic conflict between the U.S. and the foreign country. In addition, this category should include the “rewards for information” programs, based on the fact that money is a strong motivator.

### **4. Military Force**

The last, but not least, instrument that governments can use to combat international terrorism is military force. Perl claims that: “Successful use of military force for preemptive or retaliatory strikes presupposes the ability to identify a terrorist perpetrator or its state sponsor, as well as the precise location of the group, information that is often unavailable from U.S. intelligence sources<sup>25</sup>.” On the other hand, some analysts argue that military force could cause not only civilian casualties but also collateral damage to economic institutions in the operations area. In addition, such action could potentially inflate “terrorist groups’ sense of importance” and boost their recruitment effectiveness. A recent study<sup>26</sup> of the sociology and psychology of terrorism

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<sup>23</sup> Raphael Perl

<sup>24</sup> Ibid., pp. CRS-9, 10.

<sup>25</sup> Ibid., p. CRS-12.

<sup>26</sup> Rex A. Hudson, The Sociology and Psychology of Terrorism: Who Becomes a Terrorist and Why?, (Library of Congress, September 1999), available on the Internet: <http://www.fas.org/irp/threat/frd.html> [last accessed June 01, 2005].

states that “counterterrorist military attacks against elusive terrorists may serve only to radicalize large sectors of the Muslim population and damage the U.S. image worldwide.”

Moreover, diplomacy and law enforcement cooperation could be used as potential tools in the “quiver” of governments’ arsenals. The aforementioned tools aim to fulfill the four goals of the U.S. National Strategy for Combating Terrorism<sup>27</sup>. The first goal is the reduction of the capabilities, as well as the scope, of operations that terrorist organizations can conduct. The second goal is the interdiction of the support and sponsorship networks of the terrorists. The third goal is the defense of U.S. citizens and their interests. The final and most difficult goal is the elimination of the societal conditions that facilitate the recruitment of new members for terrorist organizations.

### C. SYSTEMS DYNAMICS PERSPECTIVE OF TERRORISM

The preceding discussion was provided to enhance the understanding of the main drivers and assumptions that will be used for the purpose of this study. For a long time, many research studies have resorted to the use of statistical correlation in order to strongly support their specific hypotheses or theories. The use of historical data allows researchers to relate frequencies or specific occurrences to certain events, time frame characteristics and/or populations, as well as enabling them to make inferences based on their observations.

Conversely, system dynamics modeling allows the researcher to analyze complex systems from a cause-and-effect perspective, rather than from a statistical standpoint. It takes into account the feedback structure as well as the dynamic implications and non linearity within a particular system. Furthermore, system dynamics modeling allows us to track the various flows (such as material, money, and people) as well as any accumulations as they may occur throughout the system. Nevertheless, it is important to point out that the expected outcomes are not necessarily quantitative point predictions for a particular variable, but rather a measure of the dynamic behavior pattern of the system, given the inputs and conditions in the model.

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<sup>27</sup> The White House, National Strategy for Combating Terrorism (Washington, D.C.: February 2003), 1-2.

In other words, the expected results are specific behavioral patterns that will assist in a better understanding of policies in place, or will help to find flaws in the organizational structures. The behavioral patterns can take many forms. The most common are depicted in Figure 4.

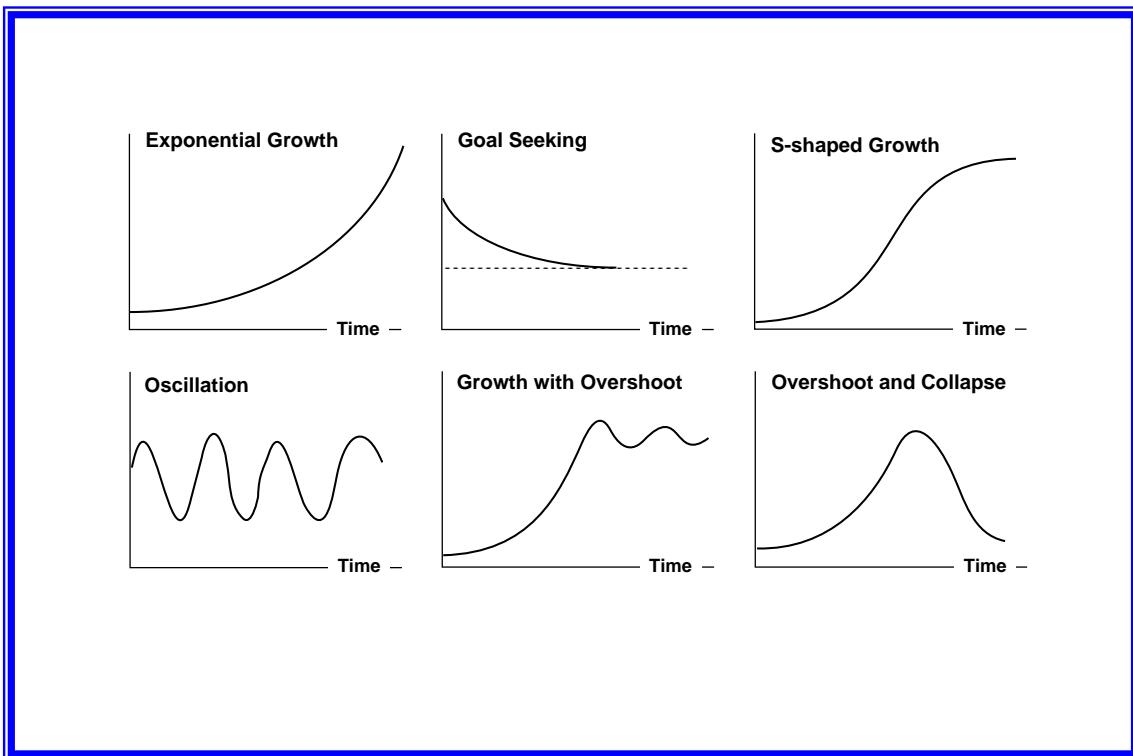


Figure 4. Common Modes of Behavior in Dynamic Systems. (Source: from John Sterman, *Business Dynamics, Systems Thinking and Modeling for a Complex World*, McGraw-Hill, (2000), Page 108)

Given the high-level concerns of the U.S. government regarding Middle Eastern Terrorist Groups and their activities, the study will carefully look into these groups. Historical data and ideological characteristics of the most prominent Middle Eastern terrorist groups such as Al Qaeda and Hezbollah, among others, will be used to create an aggregate profile that will treat the groups as one entity; this will simplify the preparation of a causal loop diagram<sup>28</sup> that will clearly show the feedback structure of the proposed system. The details about the diagram implemented in this project can be found in Chapter II.

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<sup>28</sup> Causal Loop Diagram: A map showing the causal links among variables with arrows from a cause to an effect. Definition by John Sterman, "Business Dynamics, Systems Thinking and Modeling for a Complex World," McGraw-Hill, (2000), p. 102.

The quantitative analysis part of this project was performed with the assistance of computer software developed by ISEE Systems, called Stella®. The study's goal was to properly capture the variables and factors that are relevant to the system; once developed, the model was tested and analyzed. The main areas of interest were the number of fatal victims per month (number of killed/month) and the number of terrorists (Terrorist Human Resources). However, the main hypothesis is that if a policy could be crafted to diminish or disrupt the recruitment, and thus reduce the number, of terrorists, that policy would be able to accomplish a considerable and lasting reduction in the number of attacks against the U.S. and thus reduce the number of fatal victims per month.

It is understood that the problem of terrorism will not disappear overnight and that, because of its nature, it may not disappear in the long run either. However, if the aforementioned policy is implemented, it could lead to a lower level of anti-U.S. terrorist actions.

The desired optimal behavioral pattern for the number of terrorists would be an exponential decrease, with the goal of achieving a minimum realistic level. The desired optimal behavioral pattern for the number of attacks would also be an exponential decrease, with the goal of eventual low numbers. However, given that violent acts are typically carried out by small groups of people, with a lack of strength or resources to attack openly and seeking the necessary attention to keep their causes alive, attacks will still occur. Hopefully, these attacks will not be with the same intensity that they would be if the terrorists had greater strength.

#### **D. PROJECT OUTLINE**

This project serves as a starting point for the study of, and experimentation with, policies aimed at fighting Middle Eastern terrorism against the United States. This is achieved through the creation of a dynamic system that captures the causal relationship of: Middle Eastern terrorism, the drivers that motivate recruitment as well as its violent actions, and the effect of U.S. responses.

The preceding factors are then divided into smaller components and the governing parameters quantified accordingly; these actions bring the resulting dynamic model closer to reality and thus make it more useful for policy testing.

Again, the resulting model is simulated in a virtual environment using Stella®, a reliable systems dynamic software tool. The model re-creates the current situation, reproducing the actual system as it is depicted in the causal loop diagram. However, it is important to remember that, although they follow the same principle, the causal diagram does not show the amount of detail that the model structure reflects.

Following the re-creation of the current system, various outputs depict the behavior of many elements of interest such as the number of “Terrorist Human Resources” and the number of violent acts against the U.S., among others. This valuable step allows the user to better understand the system and generate ideas to improve the behavior of specific stock elements in the model.

The observation and continuous analysis of the depicted behavior is the basis for the conclusion, as well as any recommendations, presented in this project. Again, the idea is to serve as a foundation for the study of complex systems, such as terrorism, using the modeling techniques and tools available for the study of dynamic systems.

## II. METHODOLOGY

### A. SYSTEMS THINKING MODELING APPROACH

System dynamics<sup>29</sup> is a method for analyzing problems in complex systems; it is based on a stock<sup>30</sup> and flow<sup>31</sup> structure, designed for modeling systems with numerous variables and delays between those variables. Highly complex dynamic systems tend to be virtually impossible to solve mathematically; therefore, the generally accepted and most rational approach to study them is to simulate the behavior of those systems in a computer with the aid of modern simulation software.

Making accurate quantitative predictions with systems like terrorism can be quite challenging. In these systems, numerical data on areas such as terrorist economic resources, infrastructure, and attack capabilities are sometimes impossible to obtain and/or difficult to estimate. Although researchers have leeway to make many assumptions, it is still quite difficult to assess terrorist groups, given the anonymity of and deceiving trails often left by these authors of pain. Therefore, an analysis focused on understanding the behavior modes of important elements of the problem (such as planned terrorist attacks and the number of terrorists) can definitely shed some light on the policymaking arena. The importance of focusing on the pattern rather than aiming to provide point predictions about specific variables (e.g., the number of terrorist attacks next year) is based on the fact that, since the data needed to make such predictions are mostly known to be inaccurate, they can produce inaccurate predictions. Conversely, by using system dynamics modeling, we can simulate behavior of a system based on a valid (accepted by the public) array of characteristics and behavioral elements of the problem being analyzed (e.g., terrorist groups' beliefs and effect of U.S. troops in the Middle East). By studying and understanding the resulting behavioral pattern, it is possible to find ways to affect the observed behavior and make changes to its pattern. Furthermore,

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<sup>29</sup> Originally introduced as “Industrial Dynamics” by MIT’s Jay W. Forrester (Forrester, 1961).

<sup>30</sup> Stock: Pool or inventory where accumulation of elements takes place.

<sup>31</sup> Flow: Rate at which elements move through the system.

this would certainly lead to a better understanding of the problem and would facilitate the creation of a platform that would allow analysis and testing of policies aimed at its solution.

The problem of terrorism is very complex (given the magnitude of elements that are known to cause it). Terrorism obviously has a feedback structure (since the elements within the system receive and produce feedback when interacting with each other) and it has dynamic properties (the system changes and reacts to changes in its elements). Therefore, a dynamic modeling approach can better serve the objectives set forth in this project than can a study of the statistical correlation between variables that, as said before, are realistically difficult to quantify accurately and that may not be an appropriate platform for policy testing in any case (because the system changes constantly). Furthermore, a dynamic modeling approach based on accepted theory about factors that directly motivate its behavior, and integrating other exogenous (external) factors that can also affect its behavior, would result in a more appropriate vehicle for policy analysis than relying on statistical regression analysis of historical data or doubtful estimations.

The preceding argument is not intended to imply that there are no possible ways in which statistical or probabilistic models could capture the problem presented. It implies, rather, that a dynamic approach, aided by a friendly interface, can serve as a useful tool for analysis of the presented problem without the need for a high level of mathematical and statistical competency from the reader.

## **B. PRELIMINARY ASSUMPTIONS**

Again, terrorism as a whole is a very complex problem with thousands of variables, feedback loops, stocks, flows and nonlinearities created by the interaction of the physical and unique structure of the players. Attempting to capture the behavior of the whole system in a simulation model is an enormous task that may, nonetheless, provide the closest approximation of reality in a virtual environment. However, this closeness could become as complicated as the problem in real life and may not be useful for policy analysis. Conversely, concentration in a specific area of the problem of interest may be the key to attacking the problem as a whole. In this project, the key area of interest is Terrorist Human Resources. Middle Eastern terrorist attacks of high lethality are typically

carried out by highly organized terrorist groups, such as Al Qaeda or Hezbollah. It is assumed that a reduction in the memberships of these groups may have a reinforcing<sup>32</sup> effect on their operability and their functionality. In other words, a reduction of the number of members of terrorist groups (Terrorist Human Resources) will obviously cause a reduction of the strength of these groups as well as a reduction of the support given to them. Although any competent person can arrive at the preceding conclusion without the aid of a computer model, the key item here is how to produce strategies that can effectively help reduce this factor, given the structure's complexity and the governing dynamic of the entire system. It is important to remember that there are many obvious strategies that tend to backfire when implemented; this is why it is crucial to look at the entire system in the policymaking arena. For instance, consider the impact of overt military operations such as those carried out during "Iraqi Freedom": while many of its primary objectives (e.g., depletion of insurgents) were achieved, it also produced an unexpectedly adverse effect. As suspected terrorists and insurgents were killed by American troops during daily operations, anti-American sentiment was reinforced by such things as grief for the dead and the treatment of the general population during searches, thus stimulating local and international recruitment and adding many more bodies to the insurgency, an insurgency that has claimed more U.S. soldiers' lives than did the country's regular military forces during the initial invasion. Conversely, forces from other nations also in-country (e.g., El Salvador, Dominican Republic) did not suffer such losses. The preceding example illustrates the need to identify dynamic structures and to account, not only for a single element of interest (deplete insurgency), but also for the related elements that can unexpectedly respond to feedback and thus significantly affect the expected results.

### C. THE MODEL

In an attempt to ensure the credibility and reliability of this dynamic modeling analysis, the authors' first priority was to base their ideas for the construction of the basic model only on generally accepted theories and official sources in order to avoid the

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<sup>32</sup> Reinforcing: A positive feedback relationship concept that tells us that given two things related to each other, if one thing decreases, the other will decrease or vice versa.

“garbage in, garbage out” effect<sup>33</sup>. This approach was important to ensure an unbiased and reliable platform that would allow the user to study the dynamic implications of terrorism, policy testing and analysis in a virtual environment, or simply to serve as starting point for more in-depth modeling development and related further research.

The modeling phase can be said to be divided into two stages, the first being the re-creation of the situation with Middle Eastern terrorism against the United States as it is today, based on historical behavioral data and on the concepts and assumptions described in the official sources used. The idea is to describe the current behavior of certain variables of interest, for instance, “Terrorist Human Resources” or “Number of Terrorist Violent Actions Per Month”. What are the trends? Do they appear to be changing? Are they oscillating? By studying these behavioral patterns, as well as the dynamic implications of other related factors that affect their behavior, it may be possible to determine ways to produce the desired effect. The second phase builds upon the basic model; it includes modifications to original parameters that enable us to affect the current behavior of those stocks of interest. These new modifications will shed light on the area of policymaking, as sensitivity analysis of these changes may help us to identify the areas that need to change in order to achieve the desired results. The modeling phase extends across Chapter III and Chapter IV.

#### **D. PREVIOUS WORK ON THE SUBJECT**

Although terrorism itself is a hot topic and there are a vast number of in-depth studies and papers available on the subject, very little was found about dynamic analysis of terrorism among the many excellent assessments. The Dynamic Terrorist Threat<sup>34</sup> (DTT) was of extreme usefulness due to its unique strategic and dynamic perspective on the problem. Specifically, the following quotation describes the main objective pursued:

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<sup>33</sup> “Garbage in, garbage out”; Popular modeling argot that means that no matter how good the model is, if you put unreliable data in you will get unreliable data out.

<sup>34</sup> Kim Cragin et al for the United States Air Force, “The Dynamic Terrorist Threat, An Assessment of Groups Motivations and Capabilities in a Changing World”, RAND Corporation, CA, 2004.

DTT attempts to develop a matrix that helps policymakers identify the threat that terrorist groups pose to the United States. It assesses how terrorists adapt and change, to identify such groups' vulnerabilities. By combining these two approaches, the study was able to suggest options that policymakers could use to refine the U.S. government counterterrorism policies.<sup>35</sup>

The DTT project uses statistical analysis of historical data, as well as reliable expert opinion, to formulate important decision matrixes that provide valuable insight to both policymakers and curious readers. According to the DTT report, the authors were able to evaluate the relative threat to the U.S. posed by terrorist groups through assessment of existing terrorist threats to the United States, utilizing an analytical framework that allowed them to compare the motivations and capabilities of terrorist groups against each other. They developed this framework by starting with an examination of historical patterns of terrorist activities.<sup>36</sup>

Specifically, the DTT report ranked terrorists from most to least threatening, based on the number of attacks they have carried out against U.S. and other Western targets within a specific time frame. Alternatively, The DTT report assessed the strengths and weaknesses of a specific group according to its modus operandi, number of fighters, and degree of support, but did not systematically compare it with the threat posed by other terrorist organizations. This is logical in the short run; however, it does not provide policymakers with a sense of how terrorist group capabilities could change over time. Similarly, this approach does not take into account the threat posed by groups that have not recently carried out an attack against U.S. targets, but rather have spent time deepening the anti-U.S. sentiment of their members and supporters. The DTT report argued that these seemingly inactive groups might pose a more significant threat to the United States in the medium-to-long term.

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<sup>35</sup> Kim Cragin et al.

<sup>36</sup> The numbers presented in the original DTT report were drawn from the RAND Terrorism Chronology and the RAND-MIPT [National Memorial Institute for the Prevention of Terrorism] Terrorism Incident Database, unless otherwise noted. A version is available on the Internet: <http://www.tkb.org/Home.jsp>. [last accessed June 01, 2005].

The DTT served this project as a school of thought and foundation for the formulation of formulas and assumptions that were incorporated into the basic model and helped to create and quantify important variables such as terrorist groups' strengths, capabilities and productivity, among others. The incorporation of relevant factors found in the report helped to produce a more consistent basic model that will behave in a more realistic way.

#### **E. CAUSAL LOOP DIAGRAM**

As discussed in the previous chapter, dynamic systems can be graphically represented using causal loop diagrams, among other available graphical tools. These diagrams include the ideas, variables and conditions that will support the construction of a dynamic model, which will serve as a tool for the exploration of the possible effects of the implementation of policies aimed at reducing Middle Eastern groups' acts of terrorism against the U.S.

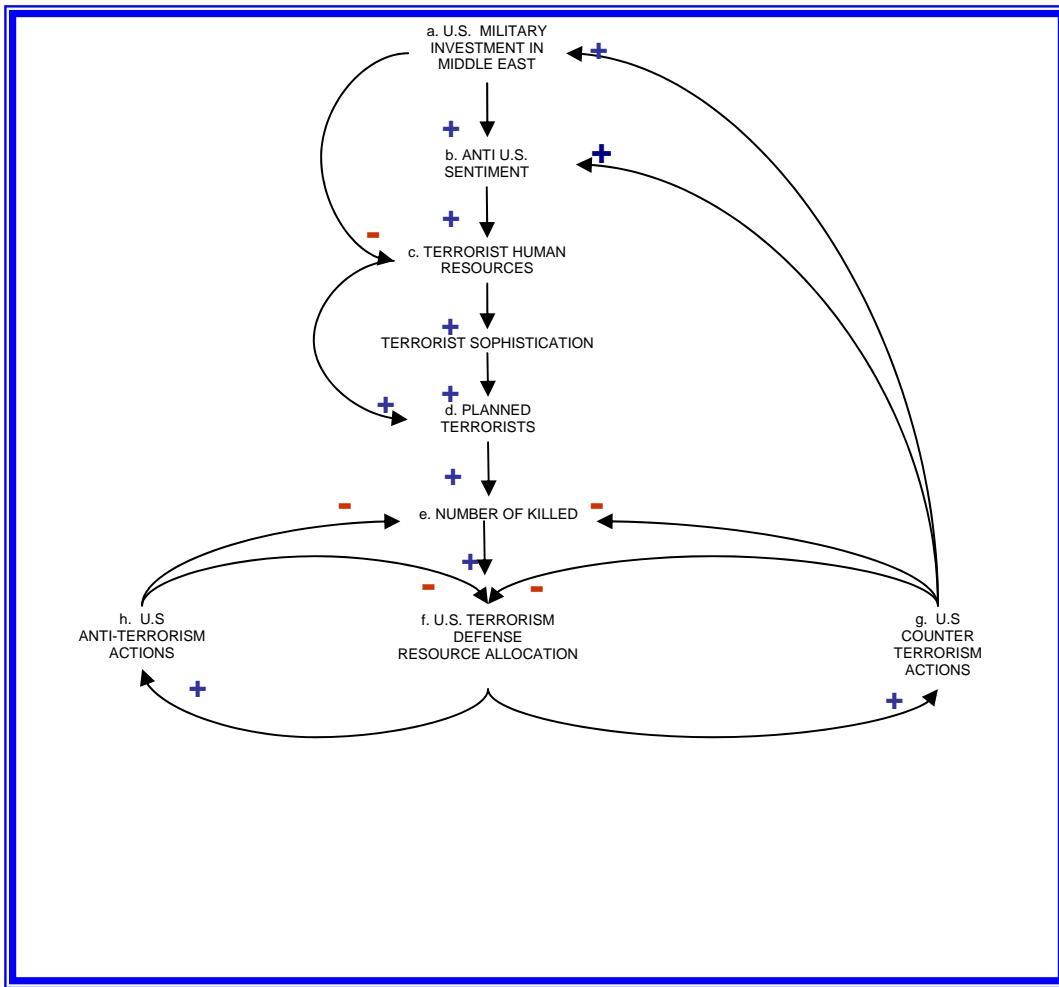


Figure 5. Causal Loop Diagram of Middle Eastern Groups Terrorism against the U.S. As Proposed by the Authors of this Project

The causal diagram shown in Figure 5 can be interpreted in the following way (from top to bottom):

- As the U.S. increases its investment (military bases and troops, in terms of funds invested) in the Middle East region, the anti-U.S. sentiment (as felt by extremist and/or anti-American groups) in the region increases. Also, as U.S. investment in the Middle East increases, the number of Terrorist Human Resources decreases.

b. As the anti-U.S. sentiment increases, this sparks the hatred of anti-American extremist groups, who feel that the U.S. presence in the Middle East threatens the Islamic conservative way of life, as well as the sovereignty of the Islamic nations in the region. Hence, those groups use religion, force and/or political causes to obtain resources and recruit more members. Therefore, Terrorist Human Resources (recruitment) increase.

c. As Terrorist Human Resources increase, terrorist sophistication (strength, lethality and/or capability) increases, and as terrorist sophistication increases, the number of planned terrorist attacks against the U.S. increases. Also, as Terrorist Human Resources increase, the number of planned attacks increases.

d. As the number of planned terrorist attacks against the U.S. increases, the number of killed (casualties resulting from the attacks) increases.

e. As the number of killed increases, U.S. terrorism defense resource allocation (defensive measures and action to avoid similar or other possible attacks) increases.

f. As U.S. terrorism defense resource allocation increases, U.S. counterterrorism actions (offensive military or non-military operations against terrorist targets) increase.

g. As U.S. counterterrorism actions increase, they have multiple effects on several variables; the effects are described as follows:

(1) The U. S. terrorism defense resource allocation decreases.

(2) The number of killed (victims from terrorism) decreases.

(3) The anti-U.S. sentiment increases. Friends and/or relatives of alleged terrorists that are killed during overt operations will reject their deaths, and thus may come to feel stronger about the anti-American cause.

(4) The U.S. military investment in the Middle East increases. The U.S. will need to mobilize more resources and thus spend more funds to operate and sustain control.

h. As U.S. antiterrorism actions increase, the U.S. terrorism defense resources allocation will decrease (as more funds are spent); it will also decrease the number of killed (victims from the attacks).

The objective of the causal loop analysis is to use the relationships depicted in the diagram as a backbone for the model (logic of relationship between the existing variables). Specifically, it is intended for use as a starting blueprint for a more detailed dynamic model, using state-of-the-art software.

## **F. MODELING SOFTWARE**

The modeling software selection, for the purpose of this project, was mainly based on the quality of the program, as well as the reputation and reliability of the source company. The program is called STELLA® and was created by ISEE Systems™ (formerly High Performance Systems), which specializes in general systems improvement.<sup>37</sup> The company was founded as a privately held company in 1985 by a professor at Dartmouth College. It is worth mentioning that in 1987 the company was awarded the Jay Forrester prize for the introduction of STELLA ®. Additionally, it has partnered with the Harvard Business School Publishing Corporation to create a line of interactive Learning Environments focused on key strategic business issues.

## **G. DATA USED**

One of the most important priorities for the authors was to ensure the reliability of the assumptions used in this study. The collection of numerical data for this project was not as extensive as it typically is in quantitative research. However, instead of being limited to a string of values in historical order, it included ideological<sup>38</sup> information about terrorist groups based on expert opinion and official or publicly accepted theories; these help explain behavior as well as providing means for its quantification. Statistical information about the number of members per terrorist group and attacks per region, among others, was obtained through reliable and fully functional internet sites for illustrational purposes rather than for producing accurate point predictions in the modeling process, although it is possible to use these to compare the behavior exhibited in the model with past trends.

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<sup>37</sup> Information source: <http://www.iseesystems.com/AboutUs.aspx> [last accessed March 09, 2005].

<sup>38</sup> Ideological in this case refers to behavioral characteristics that will be part of the feedback structure of this system, for instance, what motivates terrorist violent actions against the U.S. or its acceptance of U.S. presence on the Middle East.

Again, the idea is that quantitative data are necessary to fuel the system and to create the formulas that will produce flows and accumulations throughout the system; however, the main focus will still be on the behavioral pattern rather than on the resulting quantitative value.

### **III. MODELING**

#### **A. DYNAMIC MODEL OF MIDDLE EASTERN TERRORISM AGAINST THE UNITED STATES**

As indicated earlier, the modeling section of this project is divided into three sections: the U.S. resource accumulation in the Middle East in monetary terms, called “U.S. Military in the Middle East”; the re-creation of the situation with Middle Eastern terrorism against the U.S. as it is viewed by the public today, called “Terrorist Groups”; and the U.S. allocation of resources in anti-terrorism investment and counter-terrorism investment, what we have termed “U.S. Resource Allocation for War on Terrorism”.

The basic model stands out as one of the most important steps in this project. This is the backbone of the analysis: in this stage, the authors seek to model the problem of Middle Eastern terrorism against the U.S. The aim is to achieve an acceptable closeness to reality (realistic within reasonable boundaries) by adding what we believe are the critical elements to the structure. While the complexity of the problem on hand has been stressed repeatedly in this paper, it is important to point out that only some specific areas of interest will be integrated into the model.

Focusing on two key variables rather than trying to map the whole problem produced more reliable results, and thus further understanding of these areas. This approach should serve well as a tool for decision making. The major areas of focus were: Terrorist Human Resources and Fatal Victims of Terrorism (people killed per month). Again, one does not need a model to deduce that if these two variables were to be reduced, the problem itself would likewise be brought more under control. However, an in-depth study of the resulting dynamic interactions and existing non-linearities between these variables and their environment should make valuable contributions to the understanding of the problem.

## 1. Snapshot of the Model

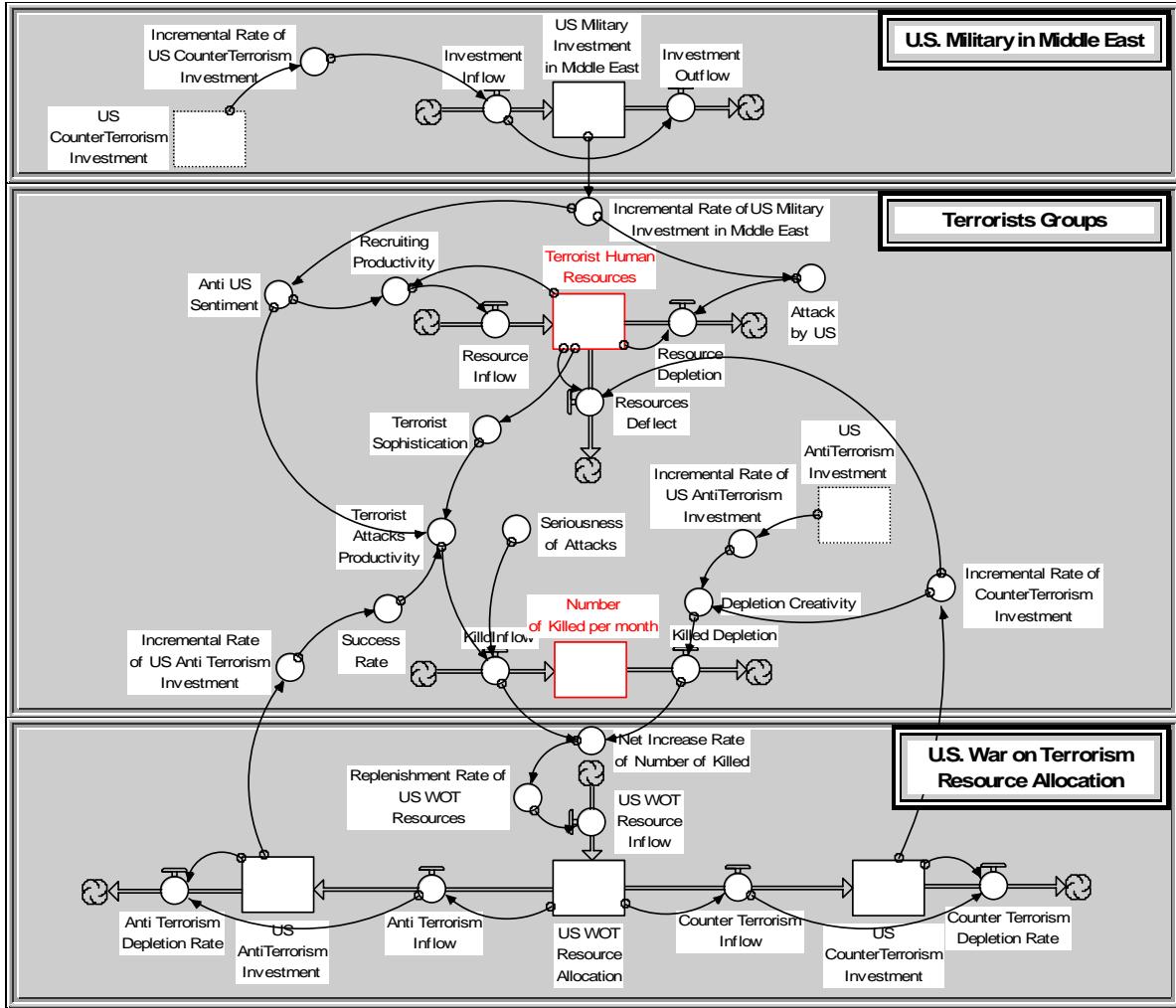
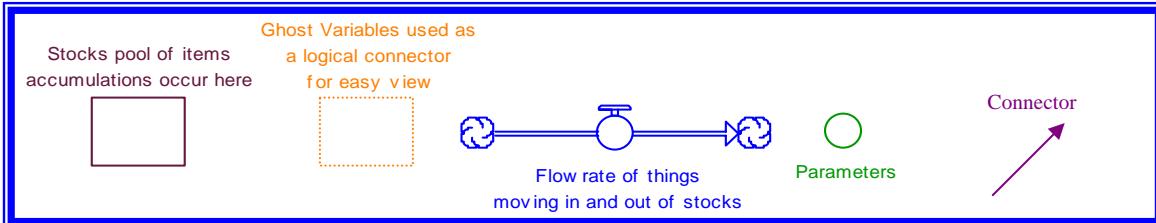


Figure 6. The basic model as seen from the Stella interface

### Symbol Explanation Chart



## 2. Model Components

The model is divided into three sections: (a) U.S. Military in the Middle East, (b) Terrorist Groups, and (c) U.S. Resource Allocation for War on Terrorism. Each section captures a part of the problem.

U.S. Military in the Middle East captures the U.S. level of involvement in the Middle East, expressed in monetary terms (U.S. Dollars). This involvement includes, but is not limited to, military offensive and other operations in the region, as well as military support to Israel, Pakistan and Jordan, among others.

The Terrorist Group section captures how the said U.S. involvement in the region affects the behavior of terrorist groups in the Middle East. The logic applied implies that U.S. presence and investment catalyze actions and responses in these groups.

The last section, U.S. Resource Allocation for War on Terrorism depicts the distribution of resources per U.S. policy. The resources being analyzed consist of U.S. investments in counter- and anti-terrorism allocated for the Middle East region.

### a. *US Military in the Middle East Section*

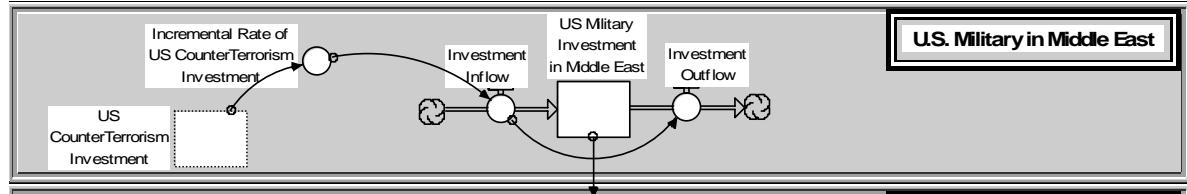


Figure 7. US Military in the Middle East Section

As stated before, U.S. Military in the Middle East (Figure 7) captures U.S. level of involvement, in monetary terms, within the Middle East. Its primary source of resources is U.S. counter-terrorism investment. The investment flow is the hose that channels these resources into and out of the U.S. military investment stock. This flow is affected by a variable that represents the incremental rate of counter-terrorism investment in the region. The level of military involvement of the U.S. with the Middle East is captured by the stock called “U.S. Military Investment in the Middle East”. This stock also interacts with a variable called “Incremental Rate of U.S. Military Investment in

M.E. (described in the second section of the model, Terrorist Groups). The depletion rate of the level is through the investment outflow. Investment outflow is the speed at which investment resources are used.

The following is a description of each of the components that interacts in this section of the model (the same format will be also used for subsequent sections). It depicts the units of measurement, important assumptions, parameters and a simplified explanation of their relationship with the model. A more mathematically oriented depiction of the relationship of each variable can be found in appendix A (Formulas).

(1) U.S. Counter-Terrorist Investment: This is simply a connection to the remotely located U.S. counter-terrorism investment stock, which holds the amount of resources, in monetary terms (U.S. dollars), allocated for counter-terrorism activities. The numbers used to quantify its initial stock include the approved budget for Iraqi Freedom and the corresponding Department of State allocations in support of counter-terrorism activities. Those allocations totaled approximately \$53.8 billion (approx. \$48.1 billion for the Department of Defense and \$5.7 billion for the Department of State) in the year 2003<sup>39</sup>. The model makes a distribution at a rate equal to “counter-terrorism inflow” with a delay of six months--lag time from appropriation to the allocation of money--at a rate of \$4.48 billion per month. A more detailed explanation of these dollar figures is in Investment Outflow.

(2) Incremental Rate of U.S. Counter-Terrorism Investment: The incremental rate of U.S. counter-terrorism investment is the difference between the initial investment and the current investment (current/initial). This can be either an increase or a decrease. It is directly related to the investment flow that goes to U.S. military investment in the Middle East.

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<sup>39</sup> Under Secretary of Defense (Comptroller) and Chief Financial Officer for the Department of Defense, April 18, 2003. Available on the Internet: [http://www.dcmilitary.com/army/pentagram/8\\_15/national\\_news/22760-1.html](http://www.dcmilitary.com/army/pentagram/8_15/national_news/22760-1.html) [last accessed June 01, 2005].

(3) Investment Inflow: The investment flow of funds for military investment is given by the availability of resources. That is, as the U.S. counter-terrorism investment becomes more productive, fewer resources should be needed to obtain the same results. The starting point for this parameter is the monthly U.S. military investment in the Middle East (\$48.1 billion/12-month period).

(4) U.S. Military Investment in the Middle East: This is a measure of the U.S. involvement in the Middle East in monetary terms (U.S. Dollars). The decision to use dollar terms was preferred over using military troops alone (number of soldiers), because this will capture the diversity of both military and political efforts in the region in a more generic way. Furthermore, this approach allows us to capture not only troops, but also equipment, allies' support, diplomatic pressure or support linked to military investment, among others. This is the state of the system; a greater state of the system leads to a slightly greater net inflow and a still larger addition to the stock<sup>40</sup>. In this case, we are facing a positive feedback loop coupling the stock and its net inflow.

According to Dov Zakheim<sup>41</sup>, the war on terror in the Middle East in 2003 was costing about \$48.1 billion per year. Iraqi Freedom cost \$2 billion a month. Enduring Freedom, the original name for the Afghanistan campaign, cost \$1.6 billion per month four years ago. Now it is still high at \$1.1 billion<sup>42</sup> per month. Mobilizing troops and equipment cost \$167 million a month, accumulating to two billion dollars in mobilization costs per year. In terms of ammunition, the spending amount is \$250 million per month, or \$3 billion per year. Another important factor is the combat pay raise authorized in 2003, \$375 million per month including benefits, totaling \$4.5 billion per year. Another interesting use of funds is funding for allies. For example, the Department of Defense has earmarked \$1.4 billion for allies such as Pakistan; the U.S. reimburses

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<sup>40</sup> Sterman, John D. Business Dynamics, Chapter 8 Closing the Loop: Dynamics of Simple Structures.

<sup>41</sup> Under Secretary of Defense (Comptroller) and Chief Financial Officer for the Department of Defense, April 18, 2003. Available on the Internet: [http://www.dcmilitary.com/army/pentagram/8\\_15/national\\_news/22760-1.html](http://www.dcmilitary.com/army/pentagram/8_15/national_news/22760-1.html) [last accessed June 01, 2005].

<sup>42</sup> Ibid.

Pakistan for stationing its troops in the northwestern part of that country. Jordan also will receive money for its help in the War on Terrorism, as many countries do. The dollar accumulation stock--the state of the system--is about \$48.1 billion.

(5) Investment Outflow: Investment outflow is the rate at which U.S. military investment in the Middle East is depleted. Investment outflow can differ significantly from investment inflow because they are governed by different decision processes. The initial value for this outflow is given by the current rate of expenditure in support of U.S. military operations (directly or indirectly), but including a delay of six months from allocation to expenditure. This assumption is based on typical military acquisitions cycle times and can be changed accordingly for sensitivity analysis, which will be shown in the next chapter. As mentioned before, the initial outflow of funds for these related activities is approximately \$4 billion per month.

### *b. Terrorist Groups Component*

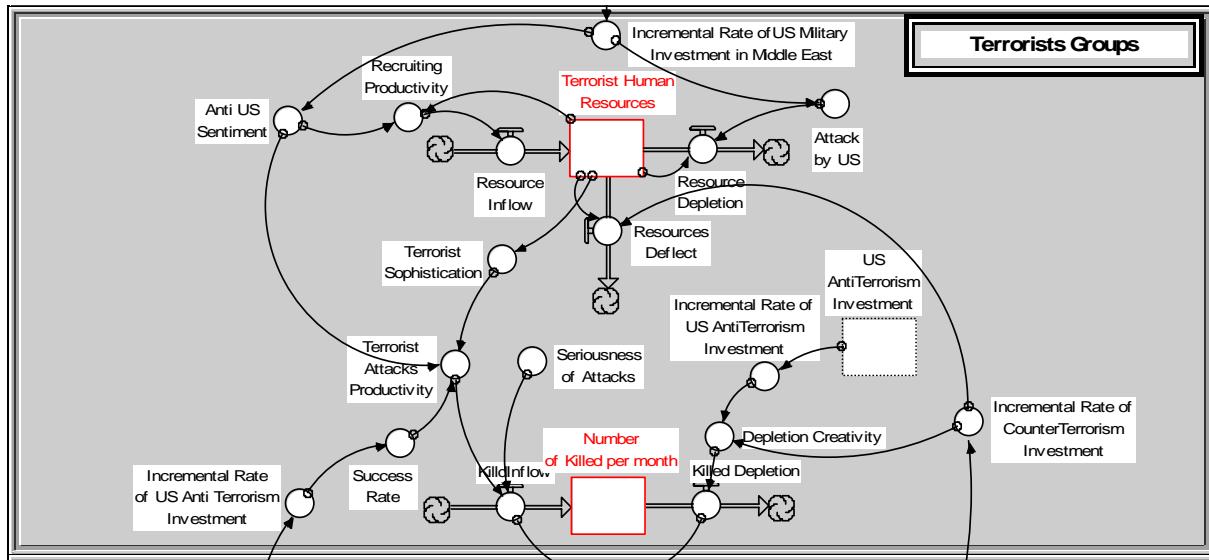


Figure 8. Terrorist Groups Component

In Chapter I, we saw that terrorist groups are negatively influenced by the U.S. military expenditures (investment, presence) in the Middle East. That investment is considered a sort of invasion of their land and their Muslim way of life (faith). This investment brings about anger and anti-U.S. sentiment, and consequently builds the

foundation for anti-U.S. demonstrations and actions against the U.S., domestically as well as against U.S. interests abroad. Those actions are built on terrorist capacity to gather resources (human, financial, and material, among others). This section gathers:

(1) Incremental Rate of U.S. Military Investment in the Middle East: The incremental rate of U.S. military investment in the Middle East is the relation between new investment and the current investment rate (new/current). An increase in military investment (more troops, more ammunition, and more allied support) will indicate an increase in the capacity to carry out operations, both covert and overt. This is the main source of anger for Middle East terrorism, and the U.S. capacity to act in the region.

(2) Anti-U.S. Sentiment: To evaluate the Middle East groups' anti-U.S. sentiment, we separated the twin criteria of intentions and capabilities<sup>43</sup> in order to use the intentions indicator<sup>44</sup>. The intentions indicator is based on five degrees of anti-U.S. sentiment; this scale was developed by RAND<sup>45</sup> and is used for estimating the level of intention of particular terrorist groups (mostly Middle Eastern) to attack the U.S. homeland and U.S. interests overseas. RAND calls this measurement "Intent Spectrum"<sup>46</sup>. The context of this measurement is similar to our anti-U.S. sentiment variable; thus it is used in our variable's construction, and its value is set at .33 (33%). Furthermore, anti-U.S. sentiment is the interaction of the "Incremental Rate of U.S. Investment in the Middle East" times (\*) one, plus (+) the anti-U.S. intent proportion of the intent spectrum. It is worth restating here that measurements of intangible elements like anti-U.S. sentiment are extremely difficult and subjective. Among the few available sources, RAND appeared to be the best source of these parameters, due to its high level of acceptance and reliability.

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<sup>43</sup> Kim Cragin et al, p. 7.

<sup>44</sup> Ibid.

<sup>45</sup> Ibid.

<sup>46</sup> The spectrum used here is given by the range of intent against the U.S. and U.S. interests, both domestic and foreign. We have a range from 1 to 5 of anti-U.S. sentiment, giving 15 possible results. The number 5, as the highest intent, represent a 33% use of the spectrum; hence 5/15 is used as a multiplier of planned terrorist attacks.

(3) Recruiting Productivity: Recruiting productivity of terrorists is a function of recruiting and the level of anti-U.S. sentiment. On the one hand, recruiting data are a combination of official and unofficial sources, interpolating the population in question. On the other hand, anti-U.S. sentiment is based on indicators of terrorist groups' intentions<sup>47</sup>.

Jihadi publications like Ghazwa, Majalla, Zarb-e-Taiba, Shamsheer and Zarb-e-Momim reveal that between January and June 2003, the various groups recruited more than 7,000 individuals aged 18-25 years from various parts of Pakistan<sup>48</sup>. This parameter used for recruitment productivity is based on these publications. It is known that recruitment varies from country to country; however, the current antiterrorism efforts by the Pakistan government and the cultural similarities shared with the rest of the Middle Eastern countries make it an appropriate measurement of recruiting rate for the Middle East as a whole. This is preferred because at the moment similar information for countries such as Iraq, Palestine and Afghanistan is not readily available from reliable sources. Also, averaging estimations throughout the region may result in a wider separation between the model and acceptable levels of realism; this is another intangible and difficult measure that can be adjusted in future studies.

The details about our measurement can be summarized as follows: 7,000 individuals divided by the Pakistani<sup>49</sup> population, times (\*) the number of countries (Middle East), with the result then divided by the time frame of the information (six months) to get the monthly rate of recruiting. Pakistan's population is 159,196,336 (July 2004 estimated), so Rate = (7,000/159 million) / 6 months = 7.34 per million/month. The

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<sup>47</sup> Kim Cragin et al for the United States Air Force, "The Dynamic Terrorist Threat, An Assessment of Groups Motivations and Capabilities in a Changing World", RAND Corporation, CA, 2004.

RAND Terrorism Chronology and RAND-MIPT Terrorism Incident Database

<sup>48</sup> Mohammad Shehzad, Interior Ministry of Pakistan, Jihad recruitment is on the rise. The Friday Times. Available on the Internet: <http://www.pakistan-facts.com/article.php?story=20030729154610902> [last accessed June 01, 2005].

<sup>49</sup> We use Pakistan as our gauge for recruiting because according to Marc Sageman's studies terrorist groups, in this case Al-Qaeda, grew in their jihad war spontaneously, leaving them vulnerable to the uncoordinated preferences of potential candidates. Therefore, they tried to remedy this by training their members in Afghanistan. After the success of the war on terrorism, they fled to Pakistan, where they currently train their members.

Middle East's population is 259,499,772 (2004 estimated)<sup>50</sup>. Then, recruitment per million is multiplied times the population. Rate =  $7.34 \times 259.5$  million = 1,904.73 which is approximately 1,905 new recruits per month.

(4) *Human Resources Inflow*: The main source of resources in our model is from recruiting. Recruiting by itself would be useless without the ignition provided by financial resources. At the same time recruiting is not instantaneous. It has a delay of approximately 12 months due primarily to selection, training, and deployment, according to Marc Sageman<sup>51</sup>.

(5) *Terrorist Human Resources*: This is an important stock that buffers the differences between human resources depletion (an elimination rate) and human resource inflow (a product of recruiting productivity times (\*) anti-U.S. sentiment).

Furthermore, Terrorist Human Resources are determined by the sum of known members of each Middle East terrorist group operating against the U.S. The number totaled 59,200 active members<sup>52</sup>. One characteristic of this stock is that its input lags behind its output due to the recruiting process. Hence, the recruiting process becomes an important ally in understanding the size phenomenon. This stock characterizes the state of the system and can provide the basis for actions<sup>53</sup>. For example, this can be used to measure the response force needed to counteract terrorist activities and planning.

(6) *Resource Depletion*: Resource depletion is the rate of reduction due to factors such as killing and capture. It is increased as a factor of attacks made by the U.S. Without other exogenous factors the rate will remain as it is now, with approximately 430 dead per month.

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<sup>50</sup> Internet World Stats. Available on the Internet: [www.internetworldstats.com/stats5.htm](http://www.internetworldstats.com/stats5.htm). [last accessed April 29, 2005].

<sup>51</sup> Foreign Policy Research Institute, Marc Sageman, Senior Fellow FPRI, Available on the Internet: [www.fpri.org/enotes](http://www.fpri.org/enotes) [last accessed April 29, 2005].

<sup>52</sup> From figures given in Table 3 and Table 6.

<sup>53</sup> Sterman, John D. Business Dynamics, Chapter 6: Stocks and Flows.

(7) *Attacks by U.S.*: This is the product of the incremental rate of U.S. military investment in the Middle East times (\*) a ratio of one. The capacity to strike Middle Eastern terrorism is a function of the military investment in the Middle East; this is a simple technical parameter to ensure that the increments of money added to the original stock are fully utilized (100% utilization); furthermore, that amount also represents the power or capability of attack by the U.S., and affects directly the number of terrorists killed (depletion).

(8) *Resource Defection*: Resource defection (terrorists deserting) is the product of the incremental rate of counter-terrorism investment times (\*) the pool of human resources. From a conservative standpoint, the rate being used for the level of defection among terrorists is 10%; this percentage will interact with the incremental rate. Again, this is another parameter that is subjective and cannot be accurately quantified due to a lack of reliable information on the subject. The figure used is simply assumed and is just another parameter that can be adjusted in future runs.

(9) *Terrorist Sophistication*: Terrorist sophistication implies the strength and capability of the terrorist groups; it is based on the twin criteria of intentions and capabilities<sup>54</sup>. The capabilities were set in accordance with five indicators of their strength. Those indicators are a set of five thresholds that were also developed by RAND; the strength thresholds are based on trends in terrorist activities over the past 30 years, overlaying this historical analysis with an assessment of more recent and emerging patterns.

The thresholds are detailed herein. They are sorted in ascending order, in relation to the ability to cause casualties and terror: first level, kill or injure 50 or more people in a single attack; second level, intentionally target unguarded foreign nationals; third level, kill or injure 150 or more people in a single attack; fourth level, strike at guarded targets; and fifth level, successfully coordinate multiple attacks. This

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<sup>54</sup> Developed from Kim Cragin and Sara E. Daly's analysis of international terrorist attacks drawn from the RAND Terrorism Chronology and RAND-MIPT Terrorism Incident Database. The RAND databases recorded approximately 3,800 international terrorist attacks from 1991 through 2000.

ability is multiplied by human resources. In this case, willingness to do any terrorist related action is not enough; that willingness must be accompanied by the capacity to carry out the action.

(10) *Terrorist Attack Productivity*: Attacks are generated by anti-U.S. sentiment, times terrorist sophistication, times success rate. As a result for the initial terrorist attack productivity number, we have 0.65 attacks per month against the U.S. only. This number is the average number of attacks against the U.S. in the last 13 years, according to RAND. It is important to point out that the authors of these data remarked that by no means are the data intended to be used as an indicator of future terrorist attacks, but rather as an indicator of past performance; however, it is the only practical and reliable measure currently available.

(11) *Killed Inflow*: This refers to the number of fatal victims of terrorist attacks; it is calculated by multiplying the seriousness of the attacks by their productivity. The seriousness of the attacks is measured by the quality of preparation of the attacks, by their caused damage in terms of death count, and by the terrorist attacks' productivity.

(12) *Seriousness of Attacks*: This is determined by the quality of the attacks, a measurement of the death toll by attacks perpetrated over time. The data utilized to quantify this variable cover a period of 13 years, as in Figure 9. Patterns of Lethality of Terrorist Attacks, in which 27 out of 101 attacks in a period of 13 years caused at least 150 deaths. Those 27 attacks correspond to a 26.7% possibility of occurrence of at least 150 deaths by a single terrorist attack.

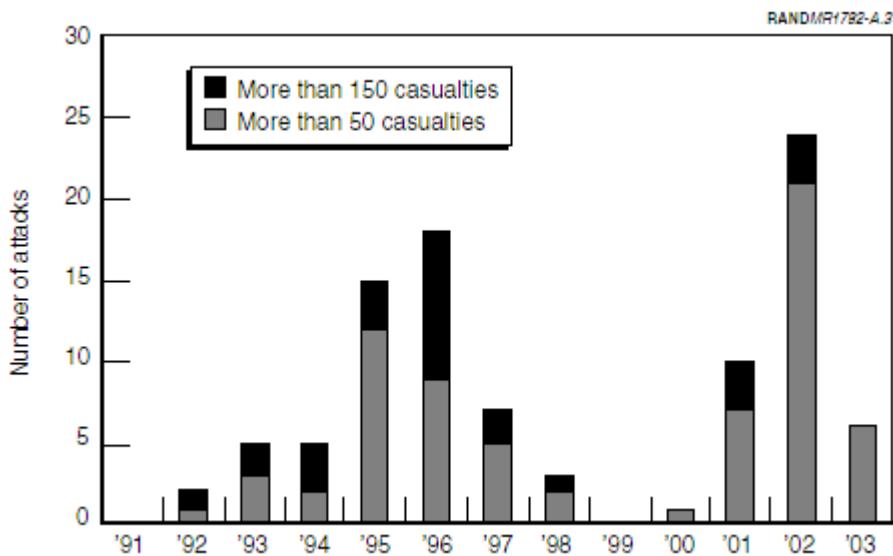


Figure 9. Patterns of Lethality of Terrorist Attacks. Source: from RAND MR1782 Report

(13) Success Rate: This is the number of successful terrorist activities carried out, divided by the total attempted; a 30% success rate is being assumed as an initial value. The higher the increases experienced in the Incremental Rate of U.S. Anti-Terrorism Investment are, the smaller the success rate of planned terrorist activities will be.

(14) Incremental Rate of U.S. Anti-terrorism Investment: The incremental rate of U.S. anti-terrorism investment is the difference between the initial investment and the current investment (current - initial). This can be an increase or decrease and directly affects the depletion creativity.

(15) Number of Killed per Month: This is the rate of people killed by terrorist activities per month. This number can vary depending upon other factors. The goal of a successful policy is to reduce this number as a measure of success.

(16) U.S. Anti-terrorist Investment: This is the stock that holds the amount of funds (in U.S. dollars) used to prevent terrorism. The budget for Homeland Security<sup>55</sup> is used to prevent terrorist attacks within the U.S., to reduce vulnerability, to

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<sup>55</sup> OMB, Mission of Homeland Security, Available on the Internet: <http://www.whitehouse.gov/omb/budget/fy2004/homeland.html>, [last accessed June 01, 2005].

minimize damage, and to assist in the recovery from terrorist attacks that occur within the U.S. It is also used to monitor the connection between illegal drug trafficking and terrorism. The initial amount used in the model is \$33.8 billion<sup>56</sup>.

(17) Incremental Rate of U.S. Anti-terrorism Investment: This is the relationship between new investment and the current investment rate. An increase in anti-terrorist investment (more homeland security readiness) will indicate an increase in the capacity to respond to high-threat areas facing greater risks of terrorist attacks.

(18) Depletion Creativity: This variable is 1.2 times the incremental rate of U.S. counter-terrorism investment and is equal to the incremental rate of U.S. anti-terrorism investment. It is assumed that counter-terrorism investment is more effective (by 20%) than anti-terrorism in the war against terrorism.

(19) Killed Depletion: This is the rate of people saved per month due to U.S. efforts against terrorism. Those efforts are counter-terrorism and anti-terrorism activities. The value assumed is 20 people, times depletion creativity.

### **c. U.S. War on Terrorism (WOT) Resource Allocation**

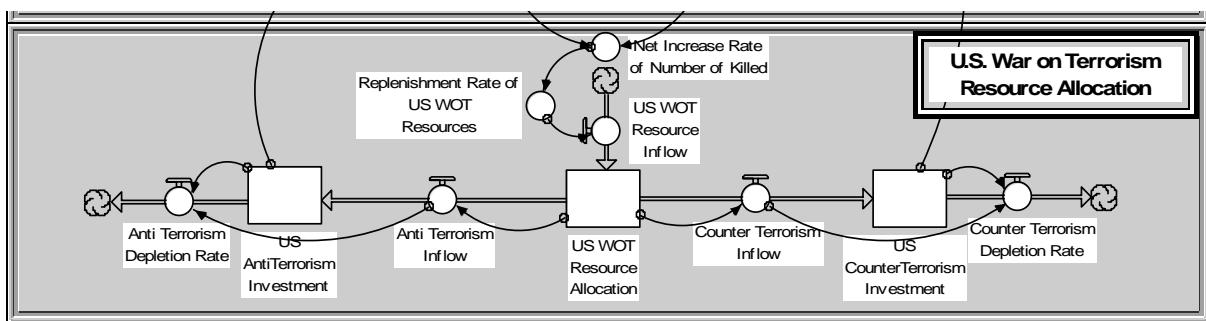


Figure 10. U.S. War on Terrorism (WOT) Resource Allocation

The U.S. Resource Allocation for War on Terrorism is composed of all resources available in place to counter the terrorism threat. This allocation obeys a different set of policies toward the aforementioned enemy. The consequences of those policies and the subsequent resource distribution will determine the Anti-terrorism Resource Inflow, as well as the dynamics that follow in the Terrorist Groups part. The following lines contain a description of every component in this allocation:

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<sup>56</sup> 2005 Discretionary Budget Authority, Office of Management and Budget (OMB), Available on the Internet: <http://www.whitehouse.gov/omb/budget/fy2005/homeland.html> [last accessed June 01, 2005].

(1) Net Increase Rate of Number of Killed: This is the difference between the number of people saved by U.S. investment in the Middle East and number of victims of terrorism, during a one-month period.

(2) Replenishment Rate of U.S. WOT resources: This variable assumes that the incremental rate of fatal victims of terrorism (the number of killed) stimulates the U.S. to replenish its anti-terrorism resources at a rate of 10-12% per year (1% per month); the assumption is subjective and is another number that could be changed for sensitivity analysis purposes, which is discussed in the next chapter.

(3) WOT Resource Inflow: This is the amount of resources allocated in response to terrorism attacks on the population (number of fatal victims). This feedback response allows U.S. anti-terrorism resource allocation to increase or decrease its level.

(4) U.S. WOT Resource Allocation: This is the total amount of resources in place. It encompasses all kinds of resources--manpower, financial, equipment, etc.--available for distribution between U.S. counter-terrorism and U.S. anti-terrorism investment. This pool of resources is determined by anti-terrorism resource inflow and counter-terrorism inflow.

Due to the lack of data regarding the value of U.S. military resources, it was decided that using the total value of the budgets allocated for Operation Iraqi-Freedom, Homeland Security and the Department of State (issues related to terrorism fighting) would represent the best value for U.S. Military resources allocated for terrorism. Hence, U.S. anti-terrorism resource allocation includes \$62.6 billion for Iraqi-Freedom, \$33.8 billion for Homeland Security, and \$5.78 billion allocated by the Department of State; this results in a grand total of \$102.1 billion for the war on terrorism.

(5) Anti-terrorism Inflow: This is the amount of resources from the U.S. anti-terrorism resource allocation to the U.S. anti-terrorism investment. This rate functions simultaneously as both an inflow and an outflow valve. We assume that this rate corresponds to the replenishment rate of U.S. anti-terrorism resources. This budget is

allocated evenly throughout the year. The rate used is derived from the \$33.8 billion allocated to Homeland Security divided by 12 months, and is equal to \$2.81 billion a month.

(6) U.S. Anti-terrorism Investment: This is as described earlier in the U.S. Military Investment in the Middle East section.

(7) Anti-terrorism Depletion Rate: This is the amount of U.S. anti-terrorism investment consumed on a monthly basis. It is assumed that U.S. anti-terrorism investment is affected by a delay of 6 months from its resource allocation.

(8) Counter-terrorism Inflow: As with anti-terrorism inflow, this is the amount of resources from the U.S. anti-terrorism resource allocation that goes to the U.S. counter-terrorism investment. This rate also functions as a simultaneous inflow and outflow; it is assumed that this rate corresponds to Replenishment Rate of U.S. Anti-terrorism Resources.

This budget is allocated evenly throughout the year. The rate is calculated by adding up the Iraqi Freedom allocation and the Department of State allocation for counter-terrorism (\$62.6 billion and \$5.78 billion, respectively), then dividing the total of \$68.3 billion by the number of months in a year (12). This yields a rate of approximately \$5.7 billion per month.

(9) U.S. Counter-terrorism Investment: This is as described in the U.S. Military Investment in the Middle East component.

(10) Counter-terrorism Depletion Rate. Counter-terrorism depletion rate is the amount of U.S. counter-terrorism investment used on a monthly basis. It is assumed that U.S. counter-terrorism investment corresponds to Counter-terrorism inflow, and is assigned a 6-month delay for allocation and execution.

The components as described in the previous sections provide the necessary feedback structure for the model to re-create the problem, as it exists. The next chapter describes in detail the resulting behavior on the first run. It also evaluates

additional runs, as well as new results achieved from a “what if” perspective. It employs sensitivity analysis to show what would happen if some of the parameters or variables were modified. Additionally, the model is compared to data presented in the RAND report for analogy and validation purposes.

## **IV. DYNAMIC BEHAVIOR AND SENSITIVITY ANALYSIS**

### **A. DYNAMIC BEHAVIOR**

The preceding chapter provided an explanation of the various components and assumptions behind the model. The next step is to explain what takes place when this model is executed. The relationship among variables was established in accordance with generally accepted theory and is consistent with reported terrorist activities.

The overall behavior-dynamic pattern can be summarized thusly: while the direct cause of Middle East terrorism is complex and highly debatable, it is agreed that the U.S. presence in the Middle East (military-political-religious intervention, relationship with Israel, etc.) is one of the stronger motivators of anti-U.S. sentiment. This sentiment is exploited by already established terrorists and used in their efforts to recruit new members to support their cause. With a larger number of terrorists, they can achieve a higher level of sophistication (strength) and planning capabilities. This higher level of strength increases the chances of greater productivity, lethality and success in carrying out their attacks, and thus increases the chances of more people being killed. The response by the U.S. to the increase in the number of successful terrorist attacks has been to continue to escalate its presence in the Middle East as well as its investment in the war against terrorism (military campaigns and operations). The resulting behavior yields interesting observations over a time span of 5 years (60 months); the system behaves as a positive loop that feeds itself or reinforces the feedback received. To illustrate these observations, an overview of the variables of greater interest to this study is provided in the following sections.

### **B. GRAPHIC BEHAVIORAL PATTERNS**

An explanatory note is attached at the bottom of each graph. Note that the numbers on the vertical axis are the units of measurement of the variable being displayed and that the horizontal axis displays the time span in months.

## 1. Terrorist Human Resources

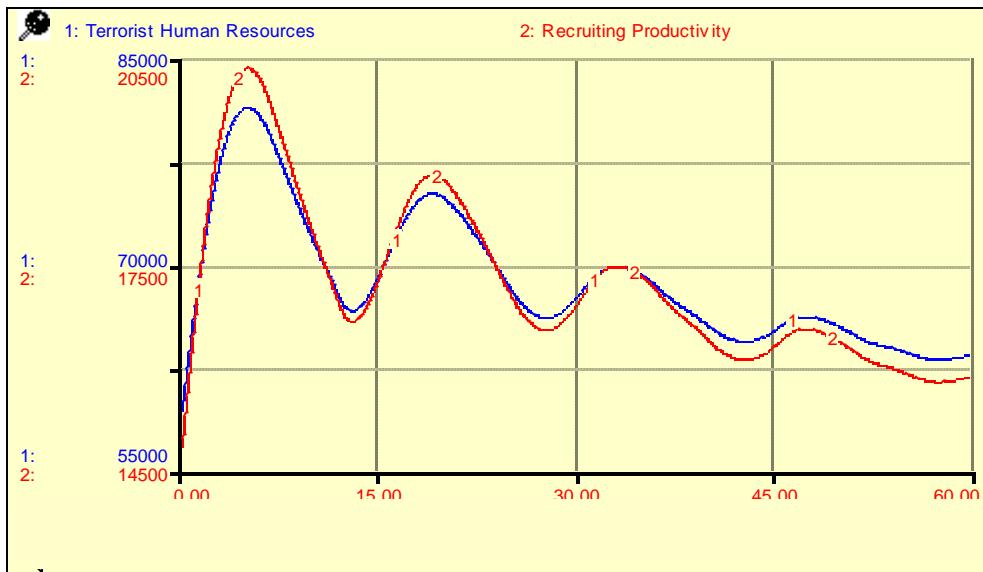


Figure 11. Terrorist Human Resources and Recruiting Productivity in 5 years

The stock of Terrorist Human Resources starts increasing from the initial default number of approximately 60,000 persons (terrorists from the Middle East region), to a maximum number of around 80,000 persons, as shown in Figure 11. Thereafter it oscillates between 80,000 and 65,000 persons. It is observed that the oscillation of the Terrorist Human Resources' behavior is strongly affected by the behavior of Terrorist Recruiting Productivity, a primal function of Terrorist Human Resources' inflow. Terrorist Human Resources' stock continues to decline with each full oscillation. This decline is caused by the correlation among Resource Inflow, Resource Depletion and Resource Defection. Initially, Resource Inflow is dominant in this loop, even though it is constant in the first 12-month period. Human resources oscillation can be explained by U.S. counter-terrorist actions, which cause a drop in this level, as terrorist are killed in military operations. This situation leads to anger and desire for revenge, feelings which are fully exploited by terrorists by use as recruitment tools and which therefore lead to further increases in terrorist numbers.

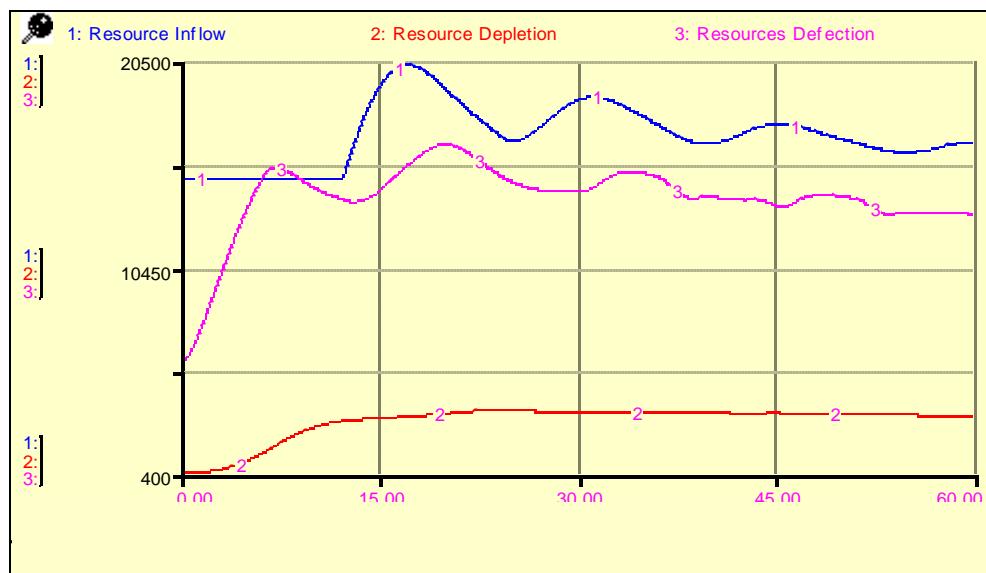


Figure 12. Resource Inflow, Resource Depletion and Resource Deflect

In Figure 12, the temporary constancy displayed by the Resource Inflow--referring to the recruitment of terrorists (Human resources)--is caused by a delay of 12 months due primarily to selection, training, and deployment. However, total outflow of Resource Depletion (terrorists killed) and Resource Defection (deserters, no longer active) overturns the dominance in a little more than a month and thereafter. In sum, these variables experience minor fluctuations but do not display any major changes in the short run. Note that the unit of measure is person (Terrorist Human Resources).

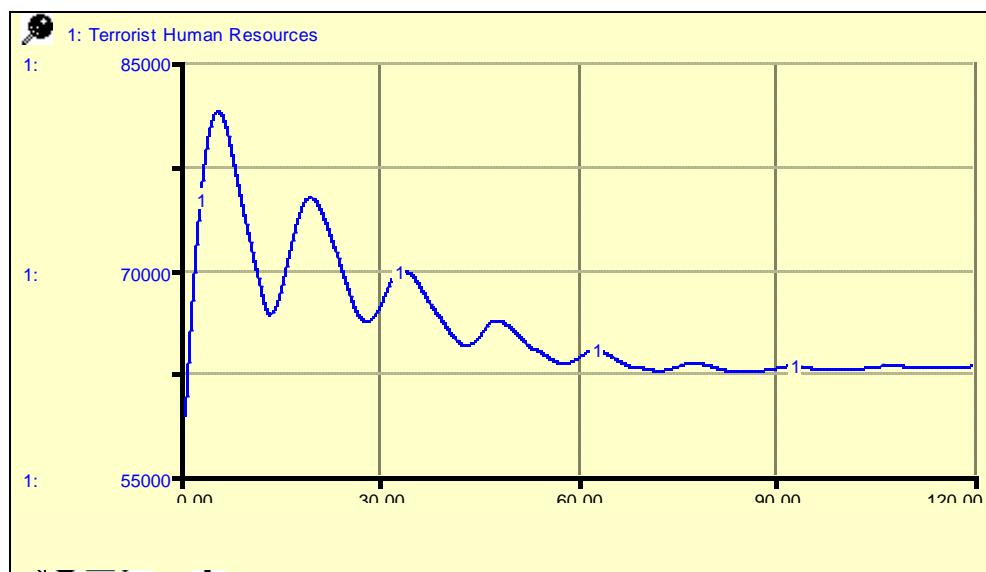


Figure 13. Terrorist Human Resources in 10 years

Figure 13 shows a long-run perspective of Terrorist Human Resources. The span is 10 years of observation and Terrorist Human Resources are almost settled down at the level of approximately 63,000 persons, on average, after six years.



Figure 14. Number of Persons Killed per Month

The variable pertaining to the number of persons killed per month starts increasing slightly from the initial number of 150 persons per month shown in Figure 14. Thereafter, it declines until it reaches the level of 60 persons in week nine. It then increases again up to 105 persons in week 35 with small oscillations, and finally declines to 50 persons at the end of the five years (60 months).

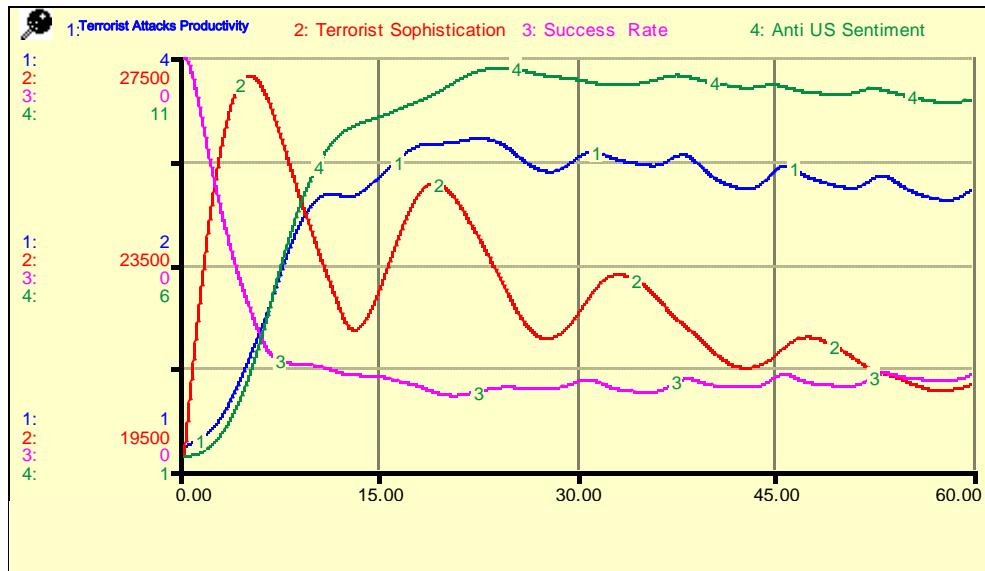


Figure 15. Comparative View of the Variables: Terrorist Attacks Productivity, Terrorist Sophistication, Success Rate and Anti-US Sentiment

The behavior of Killed Inflow is primarily determined by its parameter, Terrorist Attacks Productivity. Terrorist Attacks Productivity is a function of Terrorist Sophistication, Success Rate of Terrorist Attacks, and Anti-US Sentiment. Even though the overall decline of Terrorist Human Resources effects a reduction of Terrorist Sophistication, Terrorist Attacks Productivity increases dramatically until week 23 due to an increase of Anti-US Sentiment as shown in Figure 15. Conversely, the radical reduction of Success Rate of Terrorist Attacks is due to increased US Anti-terrorism Investment. After week 23, all elements affecting Terrorist Attacks Productivity reach a stable state of approximately three attacks per month.



Figure 16. Number of persons killed per month in 10 years

It can be observed in Figure 16 that the Number of persons killed per month settles down at the level of approximately 20 fatalities per month in the long run.

In conclusion, the model behaves in a very similar way to the real world. Most nations identify threats and respond to them upon being affected. They typically continue to respond to the threat in the same or greater proportion as they continue to be affected. According to this model, it appears that terrorism against the U.S. can be significantly reduced if the U.S. continues to increase its investment in the war against terrorism. Incremental increases of the investment seem to reduce the number of attacks in the observed timeframe. The current behavior of the model appears to satisfy the needs for which it was developed.

The following section will examine the validity of those observations.

### C. VALIDATION OF THE MODEL

To corroborate our model, we examined previous research on the subject of terrorism. We used the “Patterns in Lethality of Terrorist Attacks” presented in “The Dynamic Terrorist Threat” (DTT) published by the RAND Corporation in 2004. The behavior observed comes from the RAND Chronology and RAND-MIPT Terrorism

Incident Database, which recorded approximately 3,800 international terrorist attacks. From those attacks, only the ones whose objective was the U.S. or U.S. interests were taken into account for this study.

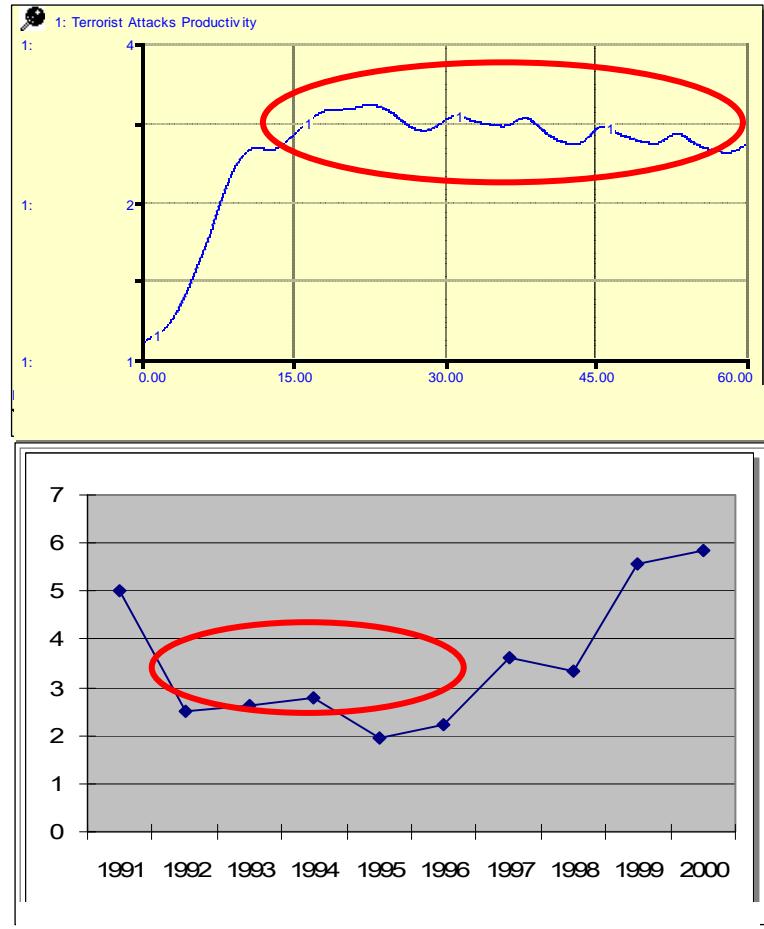


Figure 17. Comparison of Terrorist Attacks Productivity and Average Number of Attacks in RAND DTT

Here, we compare the behavior of Terrorist Attacks Productivity in our model with the Average Number of Attacks in RAND data, as shown in Figure 17. As RAND data are depicted as attacks per year, we converted these data into a monthly basis on average. In our model, terrorist attacks productivity starts low and then reaches an almost constant level at the rate of three attacks per month from the second year. The RAND historical data shows some similarity in behavior (Stabilization) from the year 1992 to

1996 (highlighted in red), and then varies as it increases to higher levels; however, this is historical data and the model shows a simulated behavioral pattern departing from the assumed feedback structure. There may be certain exogenous factors that we are unaware of, factors that may have triggered or influenced the observed historical increase in the number of attacks. Moreover, we were not able to take into account these unknown factors into our model; hence, it does not reflect this behavior.

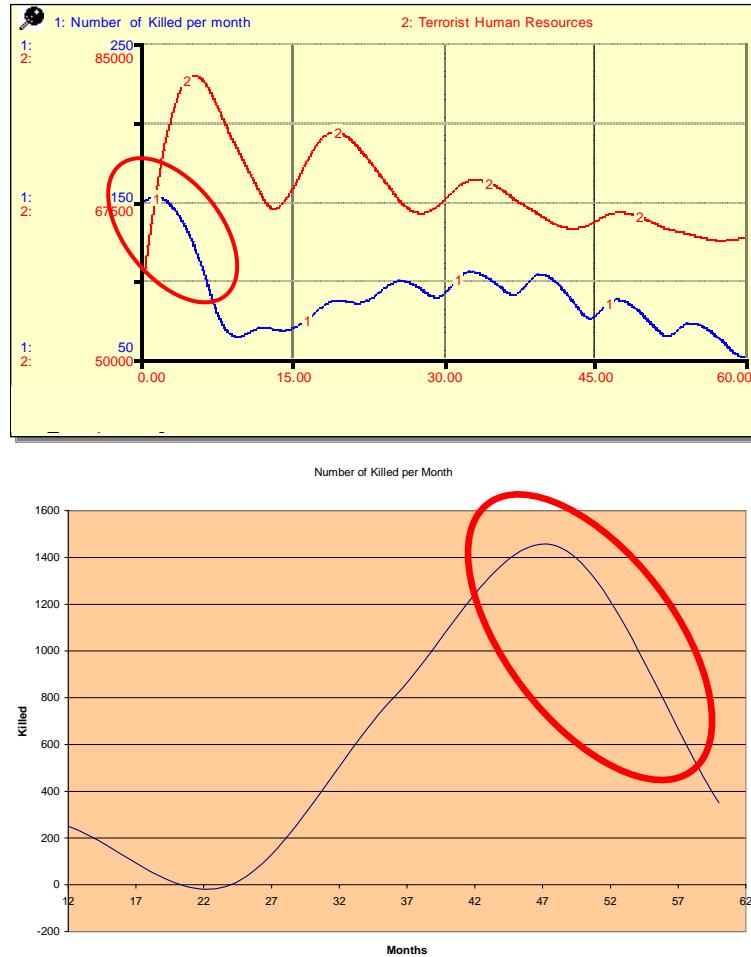


Figure 18. Comparison of Number of Killed per Month and RAND's Historical Number of Killed per month

From observing the model and the historical RAND data, we can infer that some correlation exists between them, in terms of cyclical behavior, as shown in Figure 18. The main difference is that RAND data present a historical pattern, whereas our model based

on historical data depicts the possible future trend of those casualties. However, the period from 47 months and on resembles the baseline in our model, the zero-to-ten-month period approximately, and the subsequent behavior.

#### **D. SENSITIVITY ANALYSIS**

In order to get an inside look at the consequences of different changes in our model inputs, we conducted a sensitivity analysis that looked for clues to determine in which areas the terrorism issue is more susceptible. We started by probing the U.S. War On Terrorism (WOT) Resource Allocation.

We attempted to determine how the model would behave by changing “Replenishment Rate of U.S. WOT Resources”. Herein we assumed that the incremental rate of fatal victims of terrorism (number of killed) would stimulate the U.S. to replenish its war on terrorism resources at a rate of 12% per year, as per Chapter III.

We probed the replenishment rate of U.S. WOT resources using a range from 1 to 100 percent. We used a very dramatic increase in resources to determine how Terrorist Human Resources and number of killed per month would react to large increases in U.S. investment; the figure depicts five trend lines, from one to five, valued at 1%, 25%, 50%, 75%, and 100%, respectively.

According to the aforementioned, we analyze the consequences of changing those resources upon Terrorist Human Resources. This is shown in the comparison in Figure 19.

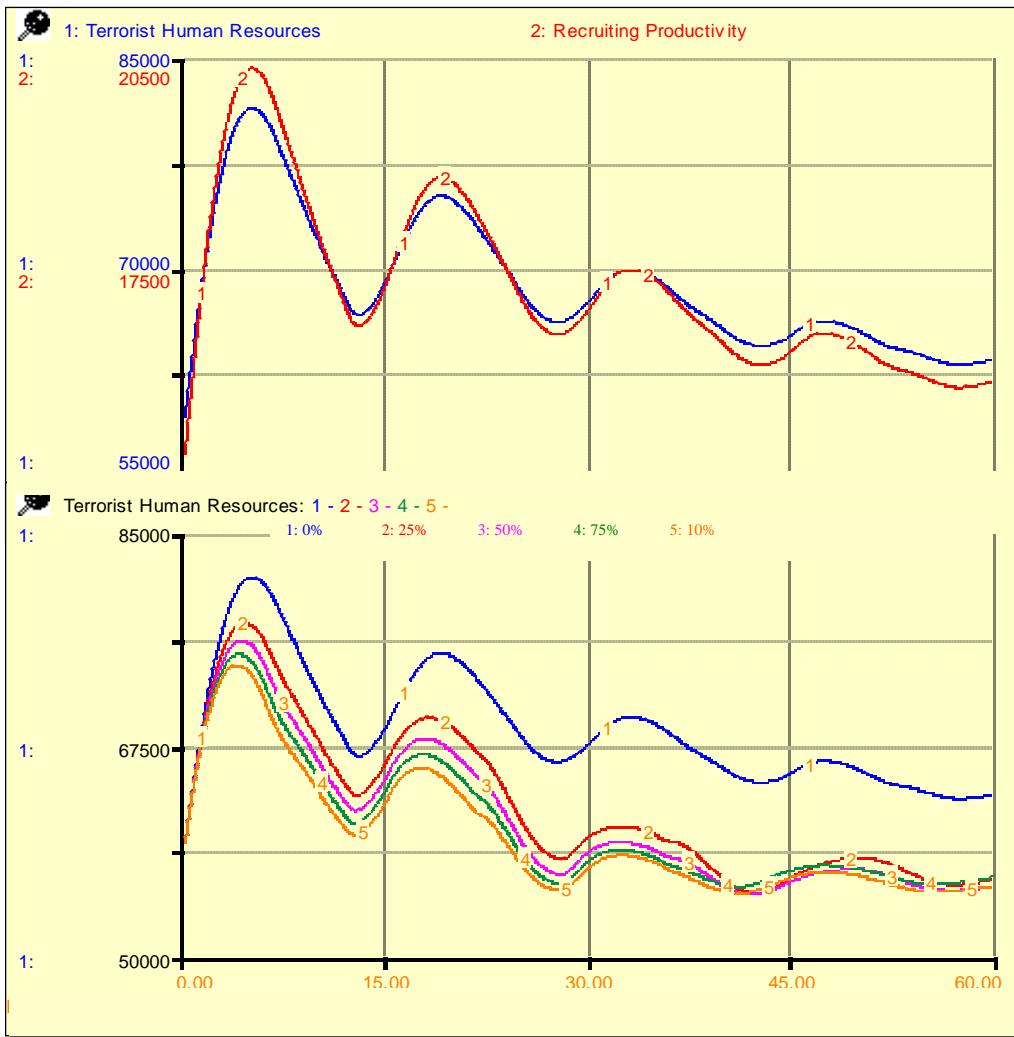


Figure 19. Original Terrorist Human Resources Behavior and Sensitivity Analysis of Terrorist Human Resources

The analysis shows that an increase in the replenishment rate of U.S. WOT resources will indeed reduce Terrorist Human Resources, as depicted in the previous figure. But at the same time, the sensitivity analysis reflects that Terrorist Human Resources will settle down at about 56,000 members. We can infer that investment alone will not end terrorism.

To finish the sensitivity analysis on U.S. investment in the War on Terrorism, we analyzed its impact upon number of killed per month, as shown in Figure 20.



Figure 20. Sensitivity Analysis of Number of Killed per Month

We see a dramatic reduction in the number of killed per month, which is very interesting when compared with the behavior of Terrorist Human Resources, because it shows small correlation between the two. This runs counter to what we thought at the beginning, as per Correlation of Number of Killed per Month and Terrorist Human Resources depicted in Figure 21. These decreases seem exaggerated (lines 2 to 5) due to the assumptions behind the increases in the replenishment resources rate. However, this could be a useful finding, subject to deeper research, to determine the way in which the two correlate to one another. At the same time, the pattern of the number of killed per month reflects the data collected by RAND, as previously shown in Figure 18.

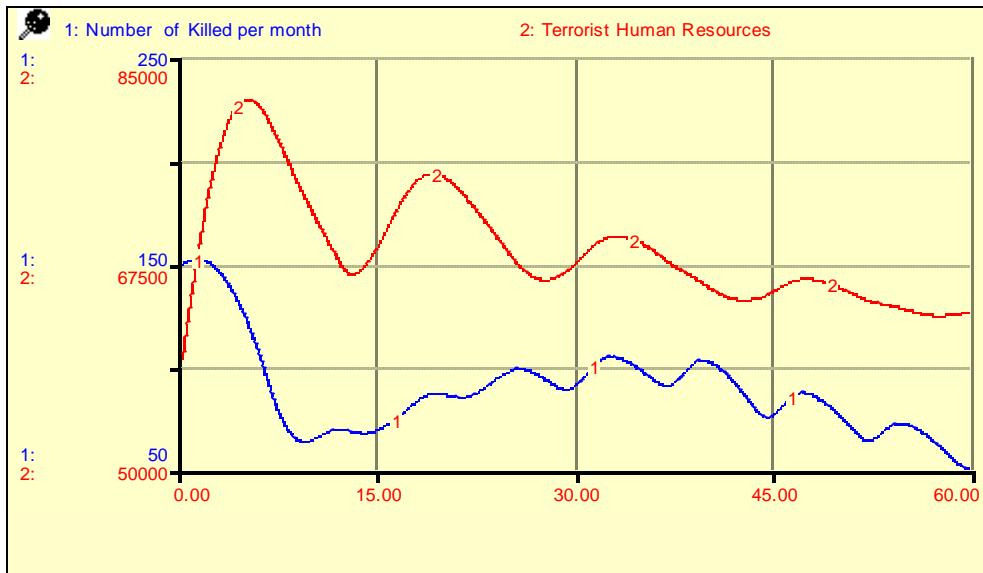


Figure 21. Correlation of Number of Killed per Month and Terrorist Human Resources

Therefore, both Terrorist Human Resources and number of killed per month were reduced by increasing the U.S. investment in the war on terrorism; however, the number of killed per month is more sensitive. This indicates that even if terrorism remains, the number of killed is significantly reduced. Hence, the cost benefit, due to budget constraints, must be calculated by acknowledging an acceptable casualty level.

After seeing the consequences on the sensitivity analysis of changing the replenishment rate of the overall U.S. war on terrorism resources, we moved to the observation of its two major components: U.S. counter-terrorism investment and U.S. anti-terrorism investment. We wanted to find out which allocation of resources is more effective in depleting Terrorist Human Resources and reducing the number of killed per month. Therefore, we did a sensitivity analysis on those components, changing the allocation ratio of total resources of the U.S. war on terrorism between the two. The range varies from 30 to 90 percent in counter-terrorism investment and 70 to 10 percent in anti-terrorism investment. We used an unrealistic allocation to probe how Terrorist Human Resources, number of killed per month, and Terrorist Human Resources deflection rate would be affected by the sensitivity analysis. The following figures depict five trend

lines, from one to five, valued at 30%, 45%, 60%, 75% and 90% of counter-terrorism investment allocation, respectively. The behavior of Terrorist Human Resources under different allocations is depicted in Figure 22.

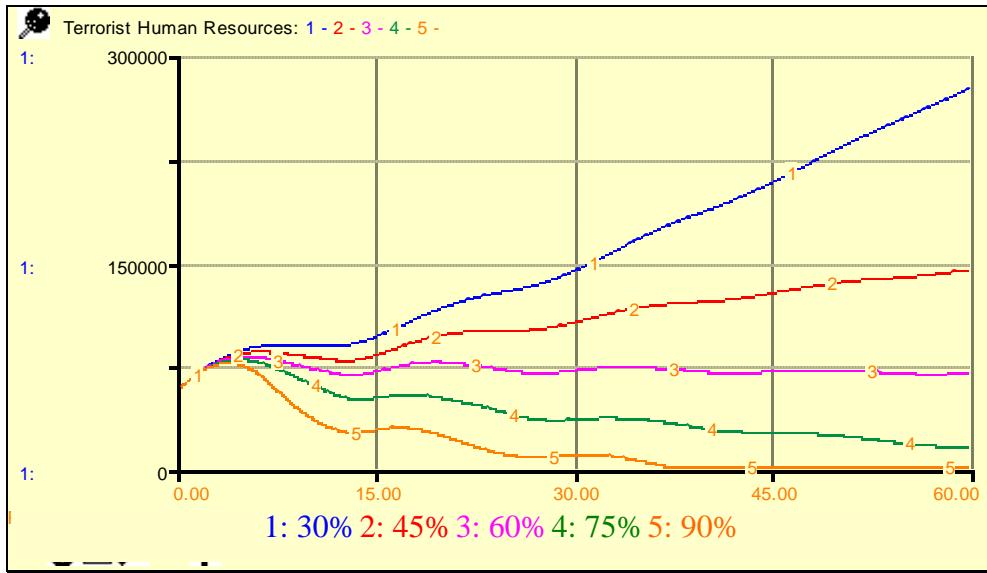


Figure 22. Terrorist Human Resources in Response to U.S. WOT Resource Allocation

As one can see, Terrorist Human Resources is very sensitive to the amount allocated between counter-terrorism investment and anti-terrorism investment. It appears obvious that more counter-terrorism investment results in less Terrorist Human Resources. However, while a 90-percent allocation is more effective in terms of reducing Terrorist Human Resources it would, in the short run, vastly increase the number of killed per month to a level of more than 235 percent the observed killing rate, as shown in line five of Figure 23. Hence, the tradeoff here is to reduce Terrorist Human Resources along with the number of killed per month. As shown in line one of the same figure, an increase in U.S. anti-terrorism resources--70 percent, in this case--reduces the number of killed per month in the short run; however, it starts to grow exponentially from the third year

on. Line two--55 percent--for U.S. anti-terrorism resources presents a similar pattern. Less than 40 percent in U.S. anti-terrorism resources does not reduce the number of killed per month in the short run, but it does result in a reduction in the middle to long run.

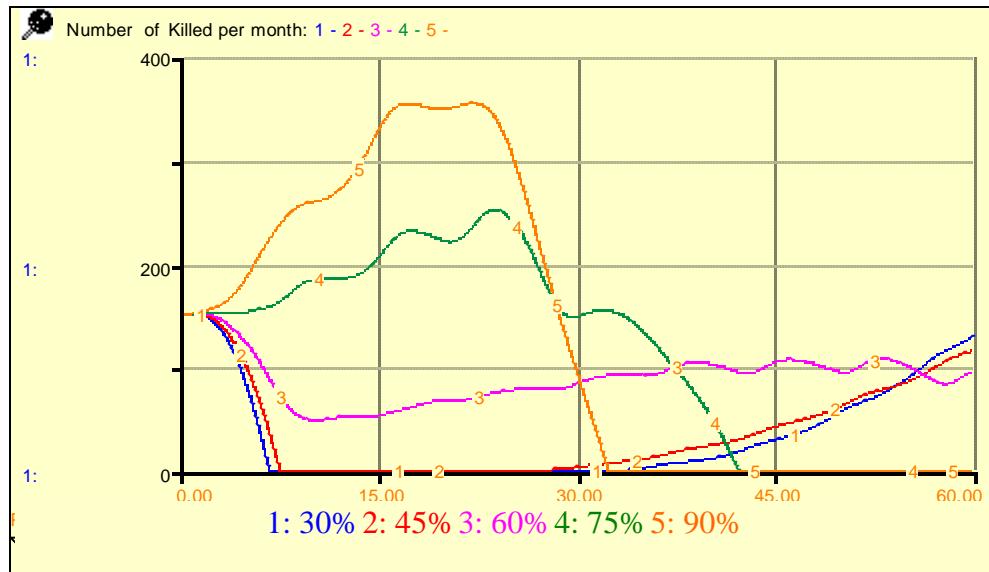


Figure 23. Number of Killed per Month due to Various U.S. WOT Resource Allocations

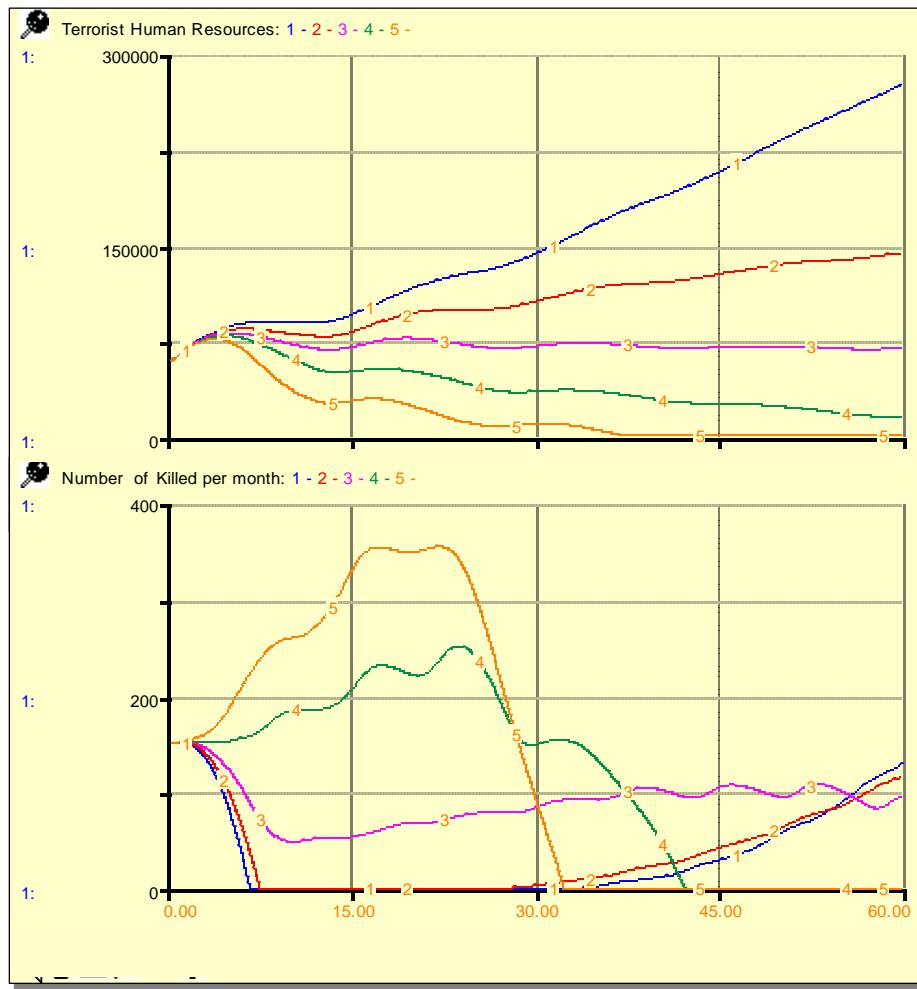


Figure 24. Comparison of Sensitivity Analysis on Terrorist Human Resources and Number of Killed per Month affected by U.S. WOT Resource Allocation

Comparing Terrorist Human Resources and the number of killed per month, as per Figure 24, we can deduce that a 60 to 75 percent counter-terrorism resource allocation--lines 3 and 4--coupled with a 40 to 25 percent anti-terrorism allocation appears to be the best allocation mix in terms of a reduction of Terrorist Human Resources and number of killed per month. Further research should be done to find out the best allocation mix of counter-terrorism resources invested in resource depletion, purely military investment, resource defection, and non-military activities.

In summary, anti-terrorism resource allocation is more effective in reducing the number of killed per month, while counter-terrorism resource allocation is more effective in reducing Terrorist Human Resources.

## V. CONCLUSION

### A. SUMMARY

This project provides both a starting point and a strong foundation for the study of U.S. policies aimed at the war against terrorism in general, as well as those aimed at terrorism's state sponsors from a systems thinking perspective<sup>57</sup>. The problem of terrorism involves a huge array of political complexities, strategic issues and national strategy elements that affect not only the U.S. but also the Middle East region. The dynamic approach proposed in this study would prove useful for the study of particular key elements that could lead to more informed decisions, and thus a better understanding of the problem. This project embraced "Number of Killed per Month" as a key area of interest as well as a gauge of effectiveness. However, it also paid special attention to "Terrorist Human Resources" as one of the key elements that directly affect the behavior pattern depicted by the Number of Killed per Month. The assumptions behind the model feedback structure are based on current accepted theory as well as on available expert opinion.

The resulting behavior demonstrated by the model shows that if the United States continues to increase its presence (Military Investment) in the Middle East, the number of terrorists (Human Resources) will be decreased gradually. This, in turn, will reduce the number of fatal victims of terrorism (Number of Killed) in the long run. This is good, in the sense that it implies that Middle Eastern terrorism activities against the U.S. would lose strength and the terrorists would suffer a decrease in their capabilities, essentially losing their ability to carry out high-lethality attacks (High Death Tolls). However, because these same practices might at the same time increase anger against the U.S., over a longer time frame the terrorist organizations will adapt, finding other means to effect attacks or increase their lethality in a period of time. This behavior is observed in the model if it is viewed from a long-run perspective (30 years). This result is obvious, in that overpowering the terrorists in the region will logically impair their ability to recruit more

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<sup>57</sup> System thinking refers to a systems dynamic modeling approach.

members and thus decrease their level of sophistication. In other words, terrorism will lose its strength. However, it is important to point out that the model also reveals that these terrorist groups do not cease to exist. This is both good and bad, in the sense that it shows the model's similarities to real-life outputs but does not guarantee that there will be a definite and final solution to the threat of terrorism. Again, in real life there is a chance that attacks will be carried out so long as a single terrorist remains alive. However, there is a higher probability that the terrorist organizations will no longer be capable of high-lethality attacks, because their planning and execution capacities will be impaired due to low sophistication.

The model also revealed that U.S. WOT Resource Allocation is a key element that plays a significant role in the reduction of terrorist activity. Furthermore, it reveals that anti-terrorism resource allocation is more effective in reducing the number of killed per month, while counter-terrorism resource allocation is more effective in reducing terrorist human resources.

## **B. FURTHER RESEARCH**

Future research using this approach could definitely produce more valuable insight, as well as more interesting results. In the modeling community, it is widely accepted that any model holds room for further improvements. However, there are always some specific areas that may need more improvement than others. In this particular case, the biggest issue is the reliability and availability of data about terrorist groups. This type of data has a subjective nature, because of the anonymity and deceptive behavior of terrorist groups. Given this limitation, one can only count on published research or government links as sources of information. Unfortunately, many are classified or restricted sources. This weakness could be overcome or diminished if the project were to be undertaken or assisted by an official agency or government entity that could provide access to more accurate information, or to those types of profile databases that typically require special clearance.

In terms of solutions, the model showed that incremental investment and actions against terrorist groups can lead to a significant reduction in the number of people killed in attacks in the long run. An additional effective measure would be the incorporation of

an educational campaign aimed at discouraging recruitment of terrorists, either by exposing the crude and real fate of those who decide to join or by showing proof that religious messages are being misused by recruiters of terrorism. The impact of a carefully elaborated and strategically implemented anti-terrorism educational campaign on the Middle East could cause a significant reduction in terrorist recruitment, and thus contribute to a degradation of terrorist sophistication. With less human resources and with fewer supporters, the terrorists' capacity to carry out substantial attacks against the U.S. would be significantly impaired. Further research about the impact of anti-terrorism educational campaigns in the Middle East region, and their dynamic implications for Middle Eastern terrorist groups, could give an interesting twist to the existing model as well as enhancing its applicability as a tool for policy testing.

In summary, it is imperative that future researchers look into the political aspects of the problem, simply because the possible corrective policies or measures would always carry a political implication that could affect domestic and foreign affairs. The benefits from a study of this nature can be maximized when unbiased elements of foreign policy are brought to the table. The considerations discussed below are based on our observations of some of the major players in the world of politics and their views about the current war against terrorism. The idea is to illustrate that a model that accounts for the various key political perspectives, but maintains simplicity, would dramatically improve the benefits obtained in this study. Therefore, future research should concentrate mainly on the dynamics of the political position of key players in the Middle East and their willingness (in quantifiable terms) to join efforts in the war against terror, on a more detailed analysis of the impact of democratization in the Middle East (in quantifiable terms), and finally on more reliable sources of information about currently active terrorist groups. These considerations will illustrate some of the political aspects that can be incorporated into, and thus enhance, the model.

### C. SUGGESTED CONSIDERATIONS FOR FURTHER RESEARCH

From a political perspective, the “antidote’s formula” of the United States against Middle East terrorism seems to be very complicated. The 9/11 Commission claims<sup>58</sup> that “Our enemy is twofold: al Qaeda, a stateless network of terrorists that struck us on 9/11; and a radical ideological movement in the Islamic world, inspired in part by al Qaeda, which has spawned terrorist groups and violence across the globe.” However, at this point it is critical to distinguish the Arab nations and the Islamic world from Middle East Terrorism. Terrorists typically use religion as a vital part of their recruitment system and pervert religious causes to carry out their attacks. Furthermore, it is common throughout the world that ordinary people, driven by disappointment, misery, anger and failure in their personal lives, are the main targets as recruits to join terrorist organizations. As the 9/11 Commission points out: “Frustrated in their search for a decent living, unable to benefit from an education often obtained at the cost of great family sacrifice, and blocked from starting families of their own, some of these young men were easy targets for radicalization<sup>59</sup>”.

In order to search for an effective “antidote” in the fight against terrorism we have looked at different policies, such as the Israeli’s “shooting and crying<sup>60</sup>” counter-terrorism policy, which imposes dramatic limitations on almost every aspect of civil liberties<sup>61</sup>. Another solution was found in the strategic teachings of Clausewitz, the solution of “exterminating” the enemy’s leadership or “neutralizing” the terrorist organizations by creating quarrels among them. Unfortunately, history has shown that the aforementioned tactics have yielded poor results, specifically in the case of terrorism, mainly because the enemy is stateless and in most cases unidentified (anonymous).

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<sup>58</sup> Edward S. Walker Jr., *Los Angeles World Affairs Council*, September 9, 2004.

<sup>59</sup> Ibid.

<sup>60</sup> Benin Joel, *No more Tears*, (Middle East Report, Issue 230, Spring 2004), p.39.

<sup>61</sup> Benjamin Netanyahu, Fighting Terrorism (New York, Ferrar, Strausand Giroux, 2001), pp. 132-146.

On the one hand, most Europeans believe that a major blow against Middle East Terrorism could be achieved if the U.S. ceases the implementation of its double-standard policy<sup>62</sup> in the Israeli-Palestinian conflict. A closer cooperation between the U.S. and the European Union (E.U.) could be considered as the “golden cut” in the fight against terrorism. The E.U. is actually the closest neighbor to the Middle East region. It has also gained ground in terms of the trust and respect of the Arab world by using more systematically the rules of multilateral diplomacy. Moreover, a survey conducted by John Zogby<sup>63</sup> in July 2004 reveals that the U.S. no longer appears as a reliable partner in Arab public opinion.

On the other hand, the U.S. insists that the suppression of terrorism should be achieved only through a huge change in the geopolitical balance of the Middle East region. Colin Powell mentioned that “The power equation in the region has changed, and governments in the region have to adjust to the new strategic situation.”<sup>64</sup> The peace between Egypt and Israel is doubtless the first step in that direction. Moreover, the U.S. has stated that the democratization of the Middle East region should act as a strong catalyst for terrorism control. However, many European researchers argue that the instability and chaotic atmosphere that resulted from the U.S. intervention in, and occupation of, Iraq is a clear indication that force alone is not the best approach to boost democratization in the Middle East. Moreover, it has been repeatedly implied by the media that U.S. policymakers need to revise the relevant policies to avoid future duplication of this phenomenon in other Middle East countries, and that they need also to consider acting in consensus with major international organizations such as the E.U. and U.N.

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<sup>62</sup> Arabs feel that the U.S. supports Israel not only with arms, but also in a moral way by neutralizing the U.N.’s resolutions against Israel with the use of its veto.

<sup>63</sup> Report of the Defense Science Board Task Force on Strategic Communication, (Washington, D.C. September, 2004), pp. 44-45.

<sup>64</sup> Lee Kuan Yew, *The IISS Asia Security Conference*, Singapore, 2003, available on the Internet: <http://www.iiss.org/newsite/Shangri-la-more.php?itemID=10>

In sum, a dynamic modeling approach accounting for the aforementioned key political implications, but structured in a simple way and supported with more reliable sources, could produce valuable insight for policymakers (e.g., the creation of variables that could resemble a unified approach to counter-terrorism, or a variable that resembles the results that could be obtained from an educational campaign to promote mutual values and understanding). However, an indispensable precondition that must be satisfied for the dynamic model to deliver its promises is that it must be unbiased. It must include all the various key political positions as feedback in the model structure, even if many of them are in contradiction with U.S. internal politics and lifestyle. The importance of a study of this nature is that it could help identify what can be done to correct our problems, taking into account our actions and their external dynamic implications for the rest of the world.

## **APPENDIX A: FORMULAS**

1. Number\_of\_Killed\_per\_month(t) = Number\_of\_Killed\_per\_month(t - dt) +  
(KilledInflow\_ - Killed\_Depletion) \* dt
2. INIT Number\_of\_Killed\_per\_month = 150

### INFLOWS:

3. KilldInflow\_ = Seriousness\_of\_Attacks\*Terrorist\_Attacks\_Productivity

### OUTFLOWS:

4. Killed\_Depletion = Depletion\_Creativity\*20
5. Terrorist\_Human\_Resources(t) = Terrorist\_Human\_Resources(t - dt) +  
(Resource\_Inflow - Resource\_Depletion - Resources\_Deflect) \* dt
6. INIT Terrorist\_Human\_Resources = 59200

### INFLOWS:

7. Resource\_Inflow = DELAY(Recruiting\_Productivity,12)

### OUTFLOWS:

8. Resource\_Depletion = Attack\_by\_US\*430
9. Resources\_Deflect =  
(Terrorist\_Human\_Resources\*.1)\*Incremental\_Rate\_of\_CounterTerrorism\_\_Inve  
stment

10.  $\text{US\_AntiTerrorism\_Investment}(t) = \text{US\_AntiTerrorism\_Investment}(t - dt) +$   
 $(\text{Anti\_Terrorism\_Inflow} - \text{Anti\_Terrorism\_Depletion\_Rate}) * dt$

11. INIT  $\text{US\_AntiTerrorism\_Investment} = 33800000000/12$

INFLOWS:

12.  $\text{Anti\_Terrorism\_Inflow} = \text{US\_AntiTerrorism\_Resource\_Allocation} * .386$

OUTFLOWS:

13.  $\text{Anti\_Terrorism\_Depletion\_Rate} = \text{DELAY}(\text{Anti\_Terrorism\_Inflow}, 6)$

14.  $\text{US\_AntiTerrorism\_Resource\_Allocation}(t) =$

$\text{US\_AntiTerrorism\_Resource\_Allocation}(t - dt) +$   
 $(\text{Anti\_Terrorism\_Resource\_Inflow} - \text{Counter\_Terrorism\_Inflow} -$   
 $\text{Anti\_Terrorism\_Inflow}) * dt$

15. INIT  $\text{US\_AntiTerrorism\_Resource\_Allocation} = 87600000000/12$

INFLOWS:

16.  $\text{Anti\_Terrorism\_Resource\_Inflow} =$   
 $\text{Replenishment\_Rate\_of\_US\_Anti\_Terrorism\_Resources} * 102100000000/12$

OUTFLOWS:

17.  $\text{Counter\_Terrorism\_Inflow} = \text{US\_AntiTerrorism\_Resource\_Allocation} * .614$

18.  $\text{Anti\_Terrorism\_Inflow} = \text{US\_AntiTerrorism\_Resource\_Allocation} * .386$

19. US\_Military\_Investment\_in\_Middle\_East(t) =  

$$\text{US\_Military\_Investment\_in\_Middle\_East}(t - dt) + (\text{Investment\_Inflow} - \text{Investment\_Outflow}) * dt$$

20. INIT US\_Military\_Investment\_in\_Middle\_East = 48100000000/12

INFLOWS:

21. Investment\_Inflow =  

$$48100000000/12 * \text{Incremental\_Rate\_of\_US\_CounterTerrorism\_Investment}$$

OUTFLOWS:

22. Investment\_Outflow = DELAY(Investment\_Inflow,6)

23. US\_CounterTerrorism\_Investment(t) = US\_CounterTerrorism\_Investment(t - dt) + (Counter\_Terrorism\_Inflow - Counter\_Terrorism\_Depletion\_Rate) \* dt

24. INIT US\_CounterTerrorism\_Investment = 53800000000/12

INFLOWS:

25. Counter\_Terrorism\_Inflow = US\_AntiTerrorism\_Resource\_Allocation \* .614

OUTFLOWS:

26. Counter\_Terrorism\_Depletion\_Rate = DELAY(Counter\_Terrorism\_Inflow,6)

27. Anti\_US\_Sentiment =  

$$\text{Incremental\_Rate\_ofUS\_Military\_Investment\_in\_Middle\_East} * (1 + 5/15)$$

28. Attack\_by\_US =  

$$\text{Incremental\_Rate\_ofUS\_Military\_Investment\_in\_Middle\_East} * 1$$

29. Depletion\_Creativity =  

$$\text{Incremental\_Rate\_of\_CounterTerrorism\_Investment} * \text{Incremental\_Rate\_of\_US\_AntiTerrorism\_Investment} * 1.2$$

30. Incremental\_Rate\_ofUS\_Military\_Investment\_in\_Middle\_East =  

$$\text{US\_Military\_Investment\_in\_Middle\_East} / \text{INIT}(\text{US\_Military\_Investment\_in\_Middle\_East})$$

31. Incremental\_Rate\_of\_CounterTerrorism\_Investment =  

$$\text{US\_CounterTerrorism\_Investment} / \text{INIT}(\text{US\_CounterTerrorism\_Investment})$$

32. Incremental\_Rate\_of\_US\_Anti\_Terrorism\_Investment =  

$$\text{US\_AntiTerrorism\_Investment} / \text{INIT}(\text{US\_AntiTerrorism\_Investment})$$

33. Incremental\_Rate\_of\_\_US\_AntiTerrorism\_\_Investment =  

$$\text{US\_AntiTerrorism\_Investment} / \text{INIT}(\text{US\_AntiTerrorism\_Investment})$$

34. Incremental\_Rate\_of\_\_US\_CounterTerrorism\_\_Investment =  

$$\text{US\_CounterTerrorism\_Investment} / \text{INIT}(\text{US\_CounterTerrorism\_Investment})$$

35. Net\_Increase\_Rate\_of\_Number\_of\_Killed = IF(KilldInflow\_-Killed\_Depletion<0) THEN 0 ELSE (KilldInflow\_-Killed\_Depletion)

36. Recruiting\_Productivity =  

$$\text{Anti\_US\_Sentiment} + (\text{Terrorist\_Human\_Resources} * .25)$$

37. Replenishment\_Rate\_of\_US\_Anti\_Terrorism\_Resources =  

$$(\text{Net\_Increase\_Rate\_of\_Number\_of\_Killed} / 100) + 1$$

38. Seriousness\_of\_Attacks =  $150 * .267$

39. Success\_Rate =  $1 / \text{Incremental\_Rate\_of\_US\_Anti\_Terrorism\_Investment} * .3$

40. Terrorist\_Attacks\_Productivity =

$$(\text{Anti\_US\_Sentiment} * \text{Terrorist\_Sophistication} * \text{Success\_Rate}) * 8.24 * 10^{-5}$$

41. Terrorist\_Sophistication = Terrorist\_Human\_Resources<sup>5/15</sup>

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